Dupl.

VIII. 330

JOURNAL

AND

PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

NEW SOUTH WALES,

1876.

VOL. X

EDITED BY

A. LIVERSIDGE,

Professor of Geology and Mineralogy in the University of Sydney.

THE AUTHORS OF PAPERS ARE ALONE RESPONSIBLE FOR THE STATEMENTS MADE AND THE OPINIONS EXPRESSED THEREIN.

AGENTS FOR THE SOCIETY:

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NOTICE

It is requested that all Communications respecting the Printing of the Journal of the Society, or List of Members, may be sent to Professor Liversidge (Editor), Union Club, Sydney.

All Donations presented to the Society are acknowledged by letter, and in the printed Proceedings of the Society.

Messrs. Trübner & Co., publishers, 57 Ludgate Hill, London, E.C., will receive for transmission books and other packets intended for the Society. Formal acknowledgments and circulars may also be sent to their care.

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3 4

ROYAL SOCIETY OF NEW SOUTH WALES.

(Imperfect - pp. 33, 34 wanting.

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1883, Dec. 5.
N. Z. exchange.
(X.–XII.)

NOTICE.

The Royal Society of New South Wales originated in 1821 as the "Philosophical Society of Australia"; after an interval of inactivity, it was resuscitated in 1850, under the name of the "Australian Philosophical Society," by which title it was known until 1856, when the name was changed to the "Philosophical Society of New South Wales"; and finally, in May, 1866, by the sanction of Her Most Gracious Majesty the Queen, it assumed its present title.

CORRIGENDA.

Page.	*Line.*	
12	**1**	For "Deputy Governor" *read* "Lieutenant Governor."
235	**27**	For "lower strata, and this" *read* "lower strata. This meets, etc."

CONTENTS.

VOLUME X.

The Royal Society of New South Wales.

OFFICERS FOR 1876–7.

PRESIDENT:

HIS EXCELLENCY SIR HERCULES ROBINSON, K.C.M.G., &c., &c., &c.

VICE-PRESIDENTS:

REV. W. B. CLARKE, M.A., F.R.S., F.G.S.
H. C. RUSSELL, B.A., F.R.A.S.

HONORARY TREASURER:

REV. W. SCOTT, M.A.

HONORARY SECRETARIES:

PROFESSOR LIVERSIDGE. | Dr. ADOLPH LEIBIUS.

COUNCIL:

LORD, THE HON. F., M.L.C.
MANNING, JAMES.
MOORE, CHARLES, F.L.S.
ROLLESTON, CHRISTOPHER.
SMITH, THE HON. J., M.D., LL.D.
WRIGHT, H. G. A., M.R.C.S.

ASSISTANT SECRETARY:

CATLETT, W. H.

FUNDAMENTAL RULES.

Object of the Society.

1. The object of the Society is to receive at its stated meetings original papers on subjects of Science, Art, Literature, and Philosophy, and especially on such subjects as tend to develop the resources of Australia, and to illustrate its Natural History and Productions.

President.

2. The Governor of New South Wales shall be *ex officio* the President of the Society.

Other Officers.

3. The other Officers of the Society shall consist of two Vice-Presidents, a Treasurer, and two or more Secretaries, who, with six other Members, shall constitute a Council for the management of the affairs of the Society.

Election of Officers.

4. The Vice-Presidents, Treasurer, Secretaries, and the six other Members of Council, shall be elected annually at the General Meeting in the month of May.

Vacancies during the year.

5. Any vacancies occurring in the Council of Management during the year may be filled up by the Council.

Fees.

6. The entrance money paid by Members on their admission shall be One Guinea; and the annual subscription shall be One Guinea, payable in advance.

The sum of Ten Pounds may be paid at any time as a composition for the ordinary annual payment for life.

Honorary Members.

7. The Honorary Members of the Society shall be persons who have been eminent benefactors to this or some other of the Australian Colonies, or distinguished patrons and promoters of the objects of the Society. Every person proposed as an Honorary Member must be recommended by the Council and elected by the Society. Honorary Members shall be exempted from payment of fees and contributions; they may attend the meetings of the Society, and they shall be furnished with copies of Transactions and Proceedings published by the Society, but they shall have no right to hold office, to vote, or otherwise interfere in the business of the Society.

Confirmation of By-laws.

8. By-laws proposed by the Council of Management shall not be binding until ratified by a General Meeting.

Alteration of Fundamental Rules.

9. No alteration of or addition to the Fundamental Rules of the Society shall be made unless carried at two successive general meetings.

BY-LAWS

Passed at a General Meeting of the Society, held June 7th, 1876.

Ordinary General Meetings.

I. An Ordinary General Meeting of the Royal Society, to be convened by public advertisement, shall take place at 8 p.m., on the first Wednesday in every month, during the last eight months of the year; subject to alteration by the Council with due notice. These meetings will be open for the reading of papers, and the discussion of subjects of every kind if brought forward in conformity with the Fundamental Rules and By-laws of the Society.

Annual General Meeting.—Annual Reports.—Election of Officers.

II. A General Meeting of the Society shall be held annually in May, to receive a Report from the Council on the state of the Society, and to elect Officers for the ensuing year. The Treasurer shall also at this meeting present the annual financial statement.

Election of the Officers and Council.

III. The Officers and other members of the Council shall be elected annually *by ballot* at the Annual General Meeting to be held in May.

IV. It shall be the duty of the Council each year to prepare a list containing the names of members whom they recommend for election to the respective offices of Vice-Presidents and Hon. Secretaries and Hon. Treasurer, together with the names of six other members whom they recommend for election as ordinary members of Council. The names thus recommended shall be proposed at one meeting of the Council, and agreed to at a subsequent meeting.

V. Each member present at the General Annual Meeting shall have the power to alter the list of names recommended by the Council, by adding to it the names of any eligible members not already included in it and removing from it an equivalent number of names, and he shall use this list with or without such alterations as a balloting list at the election of Officers and Council.

Council Meetings.

VI. Meetings of the Council of Management shall take place on the last Wednesday in every month, and on such other days as the Council may determine.

Absence from Meetings of Council.—Quorum.

VII. Any member of the Council absenting himself from three consecutive meetings of the Council, without giving a satisfactory explanation in writing, shall be considered to have vacated his office, and the election of a member to fill his place shall be proceeded with at the next Council meeting in accordance with Fundamental Rule V. No business shall be transacted at any meeting of the Council unless three members are present.

Duties of Secretaries.

VIII. The Honorary Secretaries shall perform, or shall cause the Assistant Secretary to perform, the following duties :—

1. Conduct the correspondence of the Society and Council.
2. Attend the General Meetings of the Society and the meetings of the Council, to take minutes of the proceedings of such meetings, and at the commencement of such to read aloud the minutes of the preceding meeting.
3. At the Ordinary Meetings of the members, to announce the presents made to the Society since their last meeting; to read the certificates of candidates for admission to the Society, and such original papers communicated to the Society as are not read by their respective authors, and the letters addressed to it.

4. To make abstracts of the papers read at the Ordinary General Meetings, to be inserted in the Minutes and printed in the Proceedings.
5. To edit the Transactions of the Society, and to superintend the making of an Index for the same.
6. To be responsible for the arrangement and safe custody of the books, maps, plans, specimens, and other property of the Society.
7. To make an entry of all books, maps, plans, pamphlets, &c., in the Library Catalogue, and of all presentations to the Society in the Donation Book.
8. To keep an account of the issue and return of books, &c., borrowed by members of the Society, and to see that the borrower, in every case, signs for the same in the Library Book.
9. To address to every person elected into the Society a printed copy of the Forms Nos. 2 and 3 (in the Appendix), together with a list of the members, a copy of the Fundamental Rules and By-laws, and a card of the dates of meeting; and to acknowledge all donations made to the Society, by Form No. 5.
10. To cause due notice to be given of all Meetings of the Society and Council.
11. To be in attendance at 4 p.m. on the afternoon of Wednesday in each week during the session.
12. To keep a list of the attendances of the members of the Council at the Council Meetings and at the Ordinary General Meetings of the members of the Society, in order that the same may be laid before the Society at the Annual General Meeting held in the month of May.

The Honorary Secretaries shall, by mutual agreement, divide the performance of the duties above enumerated.

The Honorary Secretaries shall, by virtue of their office, be members of all Committees appointed by the Council.

Candidates for admission.

IX. Every candidate for admission as an ordinary member of the Society shall be recommended according to a prescribed form, by not less than three members, to two of whom he must be personally known.

Election of new Members.

X. The names of such candidates, with the names of their supporters, shall be read by one of the Secretaries at an Ordinary General Meeting of the Society. The vote as to admission to take place by ballot at the next subsequent meeting. At the ballot the assent of at least four-fifths of the members voting shall be requisite for the admission of the candidate.

New Members to be informed of their election.

XI. Every new member shall receive due notification of his election, and be supplied with a copy of the obligation (No. 3 in Appendix), together with a copy of the Fundamental Rules and By-laws of the Society, a list of members, and a card of the dates of meeting.

Members whose subscriptions are unpaid to enjoy no privileges.

XII. An elected member shall not be entitled to attend the meetings nor to enjoy any privilege of the Society, nor shall his name be printed in the list of the Society, until he shall have paid his admission fee and first annual subscription, and have returned to the Secretaries the obligations signed by himself.

Members shall sign Rules—Formal admission.

XIII. Every member who has complied with the preceding By-laws shall at the first Ordinary General Meeting at which he shall be present, sign a duplicate of the aforesaid obligation in a book to be kept for that purpose, after which he shall be presented by some member to the Chairman, who, addressing him by name, shall say :—"By the authority and in the name of the Royal Society of New South Wales I admit you a member thereof."

Annual subscriptions, when due.

XIV. Annual subscriptions shall become due on the 1st of May for the year then commencing. The entrance fee and first year's subscription of a new member shall become due on the day of his election.

Subscriptions in arrears.

XV. Members who have not paid their subscriptions for the current year, on or before the 31st of May, shall be informed of the fact by the Hon. Treasurer.

And at the meeting held in July, and at all subsequent meetings for the year, a list of the names of all those members who are in arrears with their annual subscriptions shall be suspended in the Rooms of the Society. Members shall in such cases be informed that their names have been thus posted.

Resignation of Members.

XVI. No member shall be at liberty to withdraw from the Society without previously giving notice to one of the Secretaries of his desire to withdraw, and returning all books or other property belonging to the Society. Members will be considered liable for the payment of all subscriptions due from them up to the date at which they may give notice of their intention to withdraw from the Society.

Expulsion of Members.

XVII. A majority of members present at any ordinary meeting shall have power to expel an obnoxious member from the Society, provided that a resolution to that effect has been moved and seconded at the previous ordinary meeting, and that due notice of the same has been sent in writing to the member in question, within a week after the meeting at which such resolution has been brought forward.

Contributions to the Society.

XVIII. Contributions to the Society, of whatever character, must be sent to one of the Secretaries, to be laid before the

Council of Management. It will be the duty of the Council to arrange for promulgation and discussion at an Ordinary Meeting such communications as are suitable for that purpose, as well as to dispose of the whole in the manner best adapted to promote the objects of the Society.

Order of Business.

XIX. At the Ordinary General Meetings the business shall be transacted in the following order, unless the Chairman specially decide otherwise:—

1—Minutes of the preceding Meeting.
2—New Members to enrol their names and be introduced.
3—Ballot for the election of new Members.
4—Candidates for membership to be proposed.
5—Business arising out of Minutes.
6—Communications from the Council.
7—Communications from the Sections.
8—Donations to be laid on the Table and acknowledged.
9—Correspondence to be read.
10—Motions from last Meeting.
11—Notices of Motion for the next Meeting to be given in.
12—Papers to be read.
13—Discussion.
14—Notice of Papers for the next Meeting.

Admission of Visitors.

XX. Every ordinary member shall have the privilege of admitting two friends as visitors to an Ordinary General Meeting of the Society, on the following conditions:—

1. That the name and residence of the visitors, together with the name of the member introducing them, be entered in a book at the time.
2. That they shall not have attended two consecutive meetings of the Society in the current year.

The Council shall have power to introduce visitors, irrespective of the above restrictions.

Management of Funds.

XXI. The funds of the Society shall be lodged at a Bank named by the Council of Management. Claims against the Society, when approved by the Council, shall be paid by the Treasurer.

Money Grants.

XXII. Grants of money in aid of scientific purposes from the funds of the Society—to Sections or to members—shall expire on the 1st of November in each year. Such grants, if not expended, may be re-voted.

XXIII. Such grants of money to Committees and individual members shall not be used to defray any personal expenses which a member may incur.

Audit of Accounts.

XXIV. Two Auditors shall be appointed annually, at an Ordinary Meeting, to audit the Treasurer's Accounts. The accounts as audited to be laid before the Annual Meeting in May.

Property of the Society to be vested in the Vice-Presidents, &c.

XXV. All property whatever belonging to the Society shall be vested in the Vice-Presidents, Hon. Treasurer, and Hon. Secretaries for the time being, in trust for the use of the Society; but the Council shall have control over the disbursements of the funds and the management of the property of the Society.

Library.

XXVI. The Members of the Society shall have access to, and shall be entitled to borrow books from the Library, under such regulations as the Council may think necessary.

Museum.

XXVII. It shall be one of the objects of the Society to form a Museum.

Branch Societies.

XXVIII. The Society shall have power to form Branch Societies in other parts of the Colony.

Sections.

XXIX. To allow those members of the Society who devote attention to particular branches of science fuller opportunities and facilities of meeting and working together with fewer formal restrictions than are necessary at the general Monthly Meetings of the Society,—Sections or Committees may be established in the following branches of science:—

Section A.—Astronomy, Meteorology, Physics, Mathematics, and Mechanics.

Section B.—Chemistry and Mineralogy, and their application to the Arts and Agriculture.

Section C.—Geology and Palæontology.

Section D.—Biology, *i.e.*, Botany and Zoology, including Entomology.

Section E.—Microscopical Science.

Section F.—Geography and Ethnology.

Section G.—Literature and the Fine Arts, including Architecture.

Section H.—Medical.

Section I.—Sanitary and Social Science and Statistics.

Reports from Sections.

XXX. There shall be for each Section a Chairman to preside at the meetings, and a Secretary to keep minutes of the proceedings, who shall jointly prepare and forward to the Hon. Secretaries of the Society, on or before the 7th of November in each year, a report of the proceedings of the Section during that year, in order that the same may be transmitted to the Council.

Section Committees—Card of Meetings.

XXXI. The first meeting of each Section shall be appointed by the Council; at that meeting the members shall elect their own Chairman, Secretary, and a Committee of four; and arrange the days and hours of their future meetings. A card showing the dates of each meeting for the current year shall be printed for distribution amongst the members of the Society.

Money Grants to Sections.

XXXII. By application to the Council, grants of money may be made out of the General Funds of the Society to the Sections.

Membership of Sections.

XXXIII. No person who is not a member of the Society shall have the privilege of joining any of the Sections.

Form No. 1.

ROYAL SOCIETY OF NEW SOUTH WALES.

Certificate of a Candidate for Election.

Name

Qualification or occupation

Address

being desirous of admission into the Royal Society of New South Wales, we the undersigned, members of the Society, propose and recommend him as a proper person to become a member thereof.

Dated this day of , 18 .

FROM PERSONAL KNOWLEDGE.	FROM GENERAL KNOWLEDGE.

Signature of candidate

Date received 18 .

Form No. 2.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's Rooms,

Sir, Sydney, 18 .

I have the honor to inform you that you have this day been elected a member of the Royal Society of New South Wales, and I beg to forward to you a copy of the Fundamental Rules and By-laws of the Society, a printed copy of an obligation, a list of members, and a card announcing the dates of meeting during the present session.

According to the Regulations of the Society (*vide* Rule No. 6), you are required to pay your admission fee of one guinea, and annual subscription of one guinea for the current year, before admission. You are also requested to sign and return the enclosed form of obligation at your earliest convenience.

I have honor to be,

Sir,

Your most obedient servant,

To Hon. Secretary.

Form No. 3.

ROYAL SOCIETY OF NEW SOUTH WALES.

I, the undersigned, do hereby engage that I will endeavour to promote the interests and welfare of the Royal Society of New South Wales, and to observe its Rules and By-laws as long as I shall remain a member thereof.

Signed,

Address

Date

Form No. 4.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's Rooms,
Sir, Sydney, 18 .

I have the honor to inform you that your annual subscription of one guinea for the current year became due to the Royal Society on the 1st of May last.

I have the honor to be,
Sir,
Your most obedient servant,

To Hon. Treasurer.

Form No. 5.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's Rooms,
Sir, Sydney, 18 .

I am desired by the Royal Society of New South Wales to forward to you a copy of its Transactions for the year 18 , as a donation to the library of your Society.

I am further requested to mention that the Society will be thankful to receive such of the very valuable publications issued by your Society as it may feel disposed to send.

I have the honor to be,
Sir,
Your most obedient servant,

Hon. Secretary.

Form No. 6.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's Rooms,
Sir, Sydney, 18 .

On behalf of the Royal Society of New South Wales, I beg to acknowledge the receipt of and I am directed to convey to you the best thanks of the Society for your most valuable donation.

I have the honor to be,
Sir,
Your most obedient servant,

To Hon. Secretary.

Form No. 7.

Balloting List for the Election of the Officers and Council.

ROYAL SOCIETY OF NEW SOUTH WALES.

May, 18 .

BALLOTING LIST for the election of the Officers and Council.

Present Council.	Names proposed as members of the new Council.	
	Vice-Presidents.	
	Hon. Treasurer.	
	Hon. Secretaries.	
	Members of Council.	

If you wish to substitute any other name in place of that proposed, erase the printed name in the second column, and write opposite to it, in the third, that which you wish to substitute.

LIST OF THE MEMBERS

OF THE

Royal Society of New South Wales.

P Members who have contributed papers which have been published in the Society's Transactions or Journal. The numerals indicate the number of such contributions.
† Members of the Council.
‡ Life Members.

Elected.		
1864		Adams, P. F., Surveyor General, Kirribilli Point, St. Leonards.
1874		Alger, John, Macquarie-street.
1870		Allen, The Hon. George, M.L.C., Toxteth Park, Glebe.
1870		Allen, The Hon. George Wigram, M.P., Speaker of the Legislative Assembly, Elizabeth-street North.
1868		Allerding, F., Hunter-street.
1873		Allerding, H. R., Hunter-street.
1856		Allwood, Rev. Canon, B.A., *Cantab.*, Vice-Chancellor, University of Sydney, 259, Macquarie-street.
1876		Alston, John Wilson, M.B. *Edin.*, Mast. Surg. *Edin.*, 455, Pitt-street.
1876		Armstrong, W. D., Surveyor General's Office.
1876		Atchison, Cunningham Archibald, C.E., North Shore.
1873		Atherton, Ebenezer, M.R.C.S. *Eng.*, O'Connell-street.
1873		Austen, Henry, Hunter-street.
1876		Backhouse, Benjamin, Ithaca, Elizabeth Bay.
1876		Barkas, Wm. James, Lic. R. Col. Phys. *Lond.*, M.R.C.S. *Eng.*, Bombala.
1875		Bartels, W. C. W., Union Club.
1876		Bassett, W. F., M.R.C.S., *Eng.*, Bathurst.
1875		Bedford, W. J. G., M.R.C.S. *Eng.*, Staff Surgeon.
1875		Belgrave, Thomas B., M.D. *Edin.*, M.R.C.S. *Eng.*, Liverpool-street.
1875		Belisario, John, M.D. Lyons' Terrace.
1876		Benbow, Clement A., 24, College-street.
1869	P 3	Bensusan, S. L., Exchange, Pitt-street.
1876		Bennett, Samuel, Little Coogee.
1869		Bode, Rev. G. C., St. Leonards, North Shore.
1872		Bolding, H. I., P.M., Newcastle and Union Club.
1869		Boyd, Sprott, M.D. *Edin.*, M.R.C.S. *Eng.*, Lyons' Terrace.
1874		Bowen, George M. C., Keston, Kirribilli Point, North Shore.
1858		Bradridge, Thomas H., Town Hall, George-street.
1876		Brady, Andrew John, Lic. K. & Q. Coll. Phys. *Irel.*, Lic. R. Coll. Sur. *Irel.*, Sydney Infirmary.

Elected.		
1871	P 1	Brazier, John, C.M.Z.S., 11, Windmill-street.
1868		Brereton, John Le Gay, M.D. *St. Andrew's*, L.R.C.S. *Edin.*, Macquarie-street.
1874		Brewster, John, George-street.
1876		Bristowe, E. H. C., 372, Crown-street, Sydney.
1876		Brodribb, W. A., Double Bay.
1876		Brown, Henry Joseph, Newcastle.
1876		Brown, Thomas, Eskbank, Bowenfels, and Australian Club.
1876		Burn, James Henry, Moncur-street, Woollahra.
1875		Busby, The Hon. William, M.L.C., Redleaf, South Head Road, near Woollahra.
1875		Burton, Edmund, Land Titles Office, Elizabeth-street North.
1876		Cadell, Alfred, Vegetable Creek, New England.
1876		Cadell, Thomas, Wotonga, East St. Leonards.
1876		Campbell, Allan, L.R.C.P., *Glasgow*, Yass.
1876		Campbell, The Hon. Alexander, M.L.C., Woollahra.
1868		Campbell, The Hon. Charles, M.L.C., Pine Villa, Newtown.
1872		Campbell, The Hon. John, M.L.C., Campbell's Wharf, Lower George-street.
1870		Cane, Alfred, Stanley-street.
1876		Chandler, Alfred, 185 Pitt-street.
1876		Christie, Wm., L.S., Hawthorn Lodge, Glen Innes.
1850	P 19	†Clarke, Rev. W. B., M.A. *Cantab.*, F.R.S., F.G.S., C.M.Z.S., F.R.G.S., Mem. Geol. Soc. France, Corres. Imp. Roy. Geol. Inst. Austria, Hon. Mem. N.Z. Inst. Cor. Mem. Roy. Soc. Tasmania, Fellow of St. Paul's College, *Vice-President*, Branthwaite, St. Leonards, North Shore.
1874		Clay, William French, M.A., *Cantab.*, M.D. *Syd.*, M.R.C.S. *Eng.*, Fellow of St. Paul's Col., North Shore.
1876		Clune, Michael Joseph, M.A.,Lic. K. & Q. Coll. Phys. *Irel.*, Lic. R. Coll. Sur. *Irel.*, 4, Hyde Park Terrace.
1876		Codrington, John Fredk., M.R.C.S., E.; Lic. R.C. Phys., L.; Lic. R.C. Phys., *Edin.*, Orange.
1876		Colyer, John Usher Cox, A.S.N. Company, Sydney.
1856		Comrie, James, Northfield, Kurrajong.
1876		Conder, Wm., Survey Office, Sydney.
1874		Coombes, Edward, Bathurst.
1859	P 2	Cox, James, M.D. *Edin.* C.M.Z.S., F.L.S., Hunter-street.
1865	P 2	Cracknell, E. C., Superintendent of Telegraphs, Telegraph Office, George-street.
1869		Creed, J. Mildred, M.R.C.S. *Eng.*, Scone.
1870		Croudace, Thomas, Lambton.
1873		Daintrey, Edwin, Æolia, Randwick.
1876		Dalgarno, John V., Telegraph Office, George-street.
1876		Dansey, George Frederick, M.R.C.S., London, York and Margaret Streets, Wynyard Square.
1874		Dansey, John, M.R.C.S. *Eng.*, Wynyard Square.
1875		Dangar, Frederick H., Greenknowes, Darlinghurst.
1876		Darley, Cecil West, Newcastle.
1876		Davidson, L. Gordon, M.D., M.C., *Aberdeen*, Goulburn.

Elected.		
1856		Deffell, George H., Clark's-street, Hunter's Hill.
1869		De Lissa, Alfred, Pitt-street.
1875		De Salis, The Hon. Leopold Fane, M.L.C., Union Club.
1875		De Salis, L. W. junr., Union Club.
1873		Dibbs, George R., M.P., 131, Pitt-street.
1876		Dight, Arthur, Richmond.
1876		Dixon Douglas, Australian Club.
1875		Dixon, W. A., F.C.S., Hunter-street.
1876		Docker, Ernest, M.A. *Sydn.*, Roslyn st., Macleay-street.
1876		Douglas James, L.R.C.S. *Edin.*, Hope Terrace, Glebe Road.
1876		Drake, William Hedley, Commercial Bank, Inverell.
1873		Du Faur, Eccleston, F.R.G.S., Rialto Terrace.
1874		Dumaresq, William A.
1875		Eagar, The Hon. Geoffrey, Colonial Treasury, Macquarie-street.
1876		Eales, John, Duckenfield Park, Morpeth.
1876		Egan Myles, M.R.C.S., *Eng.*, 2, Hyde Park Terrace, Liverpool-street.
1874		Eichler, Charles F., M.D., *Heidelberg*, M.R.C.S., *Eng.*, Bridge-street.
1876		Eldred, W. H., 119, Castlereagh-street.
1876		Evans, George, Como, Darling Point.
1876		Evans, Owen Spencer, M.R.C.S., *Eng.*, Darling-street, Balmain.
1868		Fairfax, The Hon. John, M.L.C., *Herald* Office, Hunter-street.
1868		Fairfax, James R., *Herald* Office, Hunter-street.
1872		Farnell, J. Squire, M.P., Ryde.
1874		Fischer, Carl F., M.D., F.L.S., Soc. Zool. Bot. Vindob. Socius., 251, Macquarie-street.
1876		Fisher, Chas. Marshall, 132, Pitt-street.
1876		Fitzgerald, R. D., F.L.S., Surveyor General's Office.
1856		Flavelle, John, George-street.
1863		Fortescue, G., M.B. *Lond.*, F.R.C.S., F.L.S., Lyons' Terrace.
1875		Frazer, Hon. John, M.L.C., Quirang, Woollahra.
1876		Frean Richard, M.R.C.S. *Eng.*, Sydney Infirmary.
1876		Freehill, Bernard Austin, 130, Elizabeth-street.
1876		Firth, Rev. Frank, Wesleyan Parsonage, Newcastle.
1876		Fyffe, Benjamin, M.R.C.S. *Eng.*, Castlereagh-street.
1868	P 1	Garran, Andrew, LL.D. *Syd.*, *Herald* Office, Hunter-street.
1876		George, W. R, 172, Castlereagh-street.
1876		Gilchrist, W. O., Elizabeth Bay.
1875		Gilliat, Henry Alfred, Australian Club.
1876		Gillman, Thomas Henry, B.A., C.M., M.D., Queen's Univ. *Irel.*, Mast. Surg. Queen's Univ. *Irel.*, 20, College-street.
1876		Gipps, F. B., Strathspey House, Macquarie-street.
1859		Goodlet, John H., George-street.
1868		Goodchap, Charles, Department of Public Works, Phillip-street.
1876		Goode, George, M.B. Univ. *Dub.*, B.A., M.C.L., Eversfield House, Camden.

Elected.		
1876		Graham, Hon. Wm., M.L.C., The Union Club, Sydney.
1873		Greaves, W. A. B., Armidale.
1875		Grundy, F. H., 183, Pitt-street.
1864		Hale, Thomas, Gresham-street.
1874		Hardy, J., Hunter-street.
1874		Hay, The Hon. John, M.A., *Glasgow*, M.L.C., President of the Legislative Council, Rose Bay, Woollahra.
1876		Hayley, William Foxton, M.R.C.S., *Eng.*, Goulburn.
1876		Heaton, J. H., *Town and Country* Office, Pitt-street.
1875		Helsham, Douglass, York's Terrace, Glebe.
1876		Heron, Henry, 4, Rialto Terrace, William-street South.
1859		‡Hill, Edward S., C.M.Z.S., Rose Bay, Woollahra.
1876	P 1	Hirst, Geo. D., 379, George-street.
1868		Holt, The Hon. Thomas, M.L.C., The Warren, near Sydney.
1876		Holroyd, Arther Todd, M.B. *Cantab.*, M.D. *Edin.*, F.L.S., F.Z.S., F.R.G.S., Master-in-Equity, Sherwood Scrubs, Parramatta.
1870	P 1	Horton, Rev. Thomas, Point Piper Road, Woollahra.
1876		Icely, Thos. R., Carcoar.
1876		Jackson, Henry William, L.R.C.S. *Edin.*, Lic. R. Phys., *Edin.*, 130, Phillip-street.
1876		Jarrett, Fredk. C., 292, George-street.
1876		Jenkins, Richard Lewis, M.R.C.S., Nepean Towers, Douglass Park.
1874		Jennings, P. A., Edgecliffe Road, Woollahra.
1876		Jones, James Aberdeen, Lic. R.C. Phys,. *Edin.*, Booth-street, Balmain.
1876		Jones, Richard Theophilus, M.D. *Sydn.*, L.R.C.P. *Edin.*, Ashfield.
1867		Jones, P. Sydney, M.D. *Lond.*, F.R.C.S. *Eng.*, College-street.
1874		Jones James, Bathurst-street.
1863		Josephson, Joshua Frey, F.G.S., District Court Judge, Enmore Road, Newtown.
1876		Josephson, J. P., 253, Macquarie-street North.
1873		Kater, Henry Herman, Burwood.
1876		Keele, Thos. Wm., Harbours and Rivers Department, Phillip-street.
1873		Kennedy, Hugh, B.A. *Oxon.* Registrar of the Sydney University, Enmore Road.
1874		King, Philip G., William-street, Double Bay.
1874		Knox, George, B.A., *Cantab.*, King-street.
1875		Knox, Edward, 24, Bridge-street.
1875		Lambert, G.P., M.R.C.S. *Eng.*, Phillip-street.
1867	P 3	Lang, Rev. John Dunmore, D.D., M.A. *Glasgow*, Jamison-street.
1876		Langley, W.E., *Herald* Office, Sydney.

Elected.		
1874	P 1	Latta, G. J., O'Connell-street.
1876		Laure, Louis Thos., M.D. Surg. Univ. *Paris*, 131, Castlereagh-street.
1859	P 5	†Leibius, Adolph, Ph. D. *Heidelberg*, Senior Assayer to the Sydney Branch of the Royal Mint, *Hon. Secretary*.
1874		Lenehan, Henry Alfred, Computer,, Sydney Observatory.
1872	P 8	†Liversidge, Archibald, F.C.S.; F.G.S.; Assoc. R. S. Mines, *Lond.;* Mem. Phy. Soc. London; Mem. Mineralogical Soc. Gt. Brit. and Irel.; Cor. Mem. Roy. Soc. Tas.; Cor. Mem. Senckenberg Institute, Frankfurt; Cor. Mem. Soc. d'Acclimat. Mauritius; Professor of Geology and Mineralogy in the University of Sydney, *Hon. Secretary*, Union Club.
1875		Living, John, Marsaloo, North Shore.
1874		Lloyd, George Alfred, M.P., F.R.G.S., O'Connell-street.
1876		†Lord, The Hon. Francis, M.L.C., North Shore.
1876		Lyons, W., M.R.C.S., *Eng.*, Wollongong.
1870		Macafee, Arthur H. C., York-street.
1859		MacDonnell, William, George-street.
1868		MacDonnell, William J., F.R.A.S., George-street.
1872		Mackenzie, John, F.G.S., Examiner of Coal Fields, Newcastle.
1874		Mackenzie, W. F., M.R.C.S., *Eng.*, Lyons' Terrace.
1876		Mackenzie, Rev. P. F., Paddington.
1876		Mackellar, Chas. Kinnard, M.B., C.M., *Glas.*, Lyons' Terrace.
1876		Maclaurin, Henry Norman, M.A., M.D. Univ., *Edin.*, Lic. R. Coll. Sur. *Edin.*, 187, Macquarie-street.
1873		Makin, G. E., Berrima.
1873	P 4	†Manning, James, Milsom's Point, North Shore
1876		Manning, Frederick Norton, M.D. Univ. *St. And.*, M.R.C.S., *Eng.*, Lic. Soc. Apoth. *Lond.*, Gladesville.
1869		Mansfield, G.A., Pitt-street.
1872		Marsden, The Right Rev. Dr., Bishop of Bathurst, Bathurst.
1876		Marshall, George, M.D. Univ. *Glas.*, Lic. R. Coll. S. *Edin.*, Lyons' Terrace.
1876		Martin, Rev. George, Newtown.
1876		Martin, John, Ryde.
1875		Mathews, R. H., Mundooran.
1876		M'Carthy, W. F., Deepdeen, Glenmore Road.
1876		M'Culloch, A. H., jun., 165, Pitt-street.
1874		M'Cutcheon, John Warner, Assayer to the Sydney Branch of the Royal Mint.
1876		M'Guire, W. H., Telegraph Office, George-street.
1876		M'Kay, Charles, M.D. Univ. *St. And.*, Lic. R. Coll. Surg. *Edin.*, Church Hill.
1868		Metcalfe, Michael, Bridge-street.
1873		Milford, F., M.D., *Heidelberg*, M.R.C.S. *Eng.*, College-street.
1876		Milford, Saml. Fredk. Tollett, M.R.C.S., E., M.B. Univ. *Heidelberg*, College-street.
1876		Millard, Rev. Henry Shaw, Newcastle Grammar School.
1875		Moir, James, Margaret-street.
1875		Montefiore, E. L., Macleay-street.
1876		Montefiore, George B., 5, Gresham-street.
1856	P 4	†Moore, Charles, F.L.S., Director of the Botanic Gardens, Botanic Gardens.

Elected.		
		Morehead, R. A. A., 80, O'Connell-street.
1865	P 1	Morrell, G. A., C.E., Department of Works, Phillip-street.
1872		Morgan, Cosby William, M.D. *Brussels*, L.R.C.P. *Lond.*, 1, Grosvenor Terrace, Church Hill.
1876		Morgan, Allan Bradley, M.R.C.S. *Eng.*, Lic. Mid. Lic. R. Coll. Phys. *Edin.*, Ashenhurst, Burwood.
1876		Morgan, Thos. Cecil, Lic. R.C.S., E., L.M.R.C.S., *Irel.*, Australian Club.
1865		Murnin, M. E., Exchange, Bridge-street.
1876		Murray, W. G., Macquarie-street.
1876		Myles, Chas. Henry, Wymela, Burwood.
1873		Neill, William, City Bank, Pitt-street.
1874		Neill, A. L. P., City Bank, Pitt-street.
1874		Nicol, D., Burwood.
1876		Nield, John Cash, M.D. & C.D., *Berlin*, M.R.C.S. *Eng.*, Lic. Soc. Apoth. *Lond.*, Elzabeth-street, Sydney.
1876		Nilson, Aroid, Department of Mines.
1873		Norton, James, Elizabeth-street.
1875		Nott, Thomas, M.D. *Aberdeen*, M.R.C.S. *Eng.*, Woollahra.
1875		O'Reilly, W. W. J., M.D., M.C., Q. Univ. *Irel.*, M.R.C.S., *Eng.*, Liverpool-street.
1875		Owen, The Hon. Robert, M.L.C., 88, Elizabeth-street.
1875		Palmer, J. H., Legislative Assembly.
1876		Parbury, Chas., Union Club.
1876		Parrott, Thomas S., Ashfield.
1861		Paterson, Hugh, Macquarie-street.
1874		Pedley, Frederick, Wynyard-square.
1872		Pendergast, Robert, Hay-street.
1875		Phillip, H., Pacific Insurance Company.
1876		Pickburn Thomas, M.D., *Aberdeen*, Ch. M., M.R.C.S., *Eng.*, 40, College-street.
1862		Prince, Henry, George-street.
1876		Quaife, Fredk. Harrison, M.D., Mast. Surg. Univ. *Glas.*, Piper-street, Woollahra.
1876		Quirk, Rev. Dr. J. A., O.S.B., LL.D., *Syd.*, Lyndhurst College.
1876		Quodling, W. H., Burwood.
1865	P 1	‡Ramsay, Edward, F.L.S., Curator of the Australian Museum, College-street.
1876		Ratte, F., Noumea, New Caledonia.
1874		Read, Reginald Bligh, M.R.C.S., *Eng.*, Randwick.
1868		Reading, E., Mem. Odont. Soc. *Lond.*, Castlereagh-street.

Elected.		
1876		Reece, J. D., Surveyor General's Office.
1870		Renwick, Arthur, M.D. *Edin.*, B.A., *Sydn.*, F.R.C.S.E., 295, Elizabeth-street.
1856		Roberts, J., George-street.
1868	P 7	Roberts, Alfred, M.R.C.S. *Eng.*, Hon. Mem. Zool. and Bot. Soc. Vienna, Phillip-street.
1876		Roberts, Rev. W. H., B.A., *Dublin*, St. Paul's College, Newtown.
1871		Robertson, Thomas, M.P., Pitt-street North.
1872		Robinson, His Excellency Sir Hercules, K.C.M.G., Governor of New South Wales, Government House.
1873		Rogers, Rev. Edward, Rural Dean, Fort-street.
1856	P 10	†Rolleston, Christopher, Auditor General, Castlereagh-street.
1865		Ross, J. Grafton, 24, Bridge-street.
1876		Rowling, Dr., Mudgee.
1864	P 9	†Russell, Henry C., B.A., *Syd.*, F.R.A.S., F.M.S., Hon. Mem. S. Aust. Inst., Government Astronomer, Sydney Observatory, *Vice-President.*
1875		Sahl, Charles L., German Consul, Consulate of the German Empire, Wynyard Square.
1876		Saliniere, Rev. E. M., Glebe.
1876		Samuel, The Hon. Saul, C.M.G., M.L.C., Gresham-street.
1876		Schuette, Rudolf, M.D., Univ. *Göttingen*, Lic. Soc. Apoth. *Lond.*, 10, College-street.
1856	P 8	†‡Scott, Rev. William, M.A. *Cantab.*, Hon. Mem. Roy. Soc. Vic., Warden of St. Paul's College, *Hon. Treasurer*, St. Paul's College, Newtown.
1876		Scott, A.W., M.A. *Cantab.*, Ferndale, South Head Road.
1876		Sedgwick, Wm. Gillett, M.R.C.S., *Eng.*, Newtown.
1876		Sharp, James Burleigh, J.P., Clifton Wood, Yass.
1876		Sharp, Henry, Green Hills, Adelong.
1875		Sheppard, Rev. G., Elizabeth-street.
1876		Shields, John, M.R.C.S., *Ed.*, Bega.
1873		Simon, Eugene, Consul for France, French Consulate, George-street.
1875		Slade, G.P., Wheatley, North Shore.
1873		Sleep, John S., 139, Pitt-street.
1852	P 7	†Smith, John, The Hon., M.D., LL.D., *Aberdeen*, M.L.C., F.C.S., Hon. Mem. Roy. Soc. Vic., Professor of Physics and Chemistry in the University of Sydney, 193, Macquarie-street.
1875		Smith, Robt., B.A., *Syd.*, Solicitor, Bridge-street.
1874		Smith, John M'Garvie, 404, George-street.
1876		Smith, R. S., Surveyor General's Office.
1876		Southey, H.E., Oaklands, Mittagong.
1870		Spencer, Walter W., Lyons' Terrace.
1876		Stackhouse, Thos., Commander R.N., Australian Club.
1874		Stephen, Edward M., Macleay-street.
1872	P 1	Stephen, George Milner, B.A., F.G.S., Mem. Geol. Soc. of Germany; Cor. Mem. Nat. Hist. Soc., Dresden; F.R.G.S. of Cornwall; Ashfield.
1857		Stephens, William John, M.A. *Oxon.*, 233, Darlinghurst Road.
1876		Stopps, Arthur J., Surveyor General's Office.

Elected.		
1876		Strong, Wm. Edmund, M.D., *Aberdeen*, M.R.C.S., *Eng.*, Liverpool.
1874		Stuart, The Hon. Alexander, M.P., Colonial Treasurer, Clunes, Cambridge-street, South Kingston, Petersham.
1876		Stuart, Clarendon, Upper William Street South.
1876		Suttor, Wm. Henry, J.P., Cangoura, Bathurst.
1874		Taylor, Chas., M.D. *Syd.*, M.R.C.S., *Eng.*, Parramatta.
1876		Tayler, William George, F.R.C.S., *Lond.*, 219, Pitt-street.
1862	P 4	Tebbutt, John, junr., F.R.A.S., Private Observatory, Windsor.
1876		Tennant, E. G., M.R.C.S.E., Orange.
1870	P 1	Thompson, H. A., O'Connell-street.
1875		Thompson, Joseph, Potts' Point.
1876		Thomas, H., Arding, Narellan.
1876		Thomas, Wm. Smith, M.R.C.S., *Eng.*, Wollongong.
1876		Tibbits, Walter Hugh, Dubbo.
1876		Toohey, J. T., Melrose Cottage, Cleveland-street.
1873		Trebeck, Prosper N., George-street.
1876		Trouton, F. H., A.S.N. Company's Offices, Sydney.
1868		Tucker, William, Clifton, North Shore.
1875		Tulloh, W. H., Margaret-street.
1875		Turner, G., Argyle Terrace, Redfern.
1874		Vessey, Leonard A., Survey Office.
1876		Voss, Houlton H., Union Club.
1867		Walker, Philip B., Telegraph Office, George-street.
1870		Wallis, William, Moncur Lodge, Potts' Point.
1867		Ward, R. D., M.R.C.S. *Eng.*, North Shore.
1876		Waterhouse, J. M.A. *Syd.*, Newington College, Parramatta.
1876		Watkins, John Leo, B.A. *Cantab.*, M.A. *Syd.*, Randwick.
1876		Watson, C. Russell, M.R.C.S., *Eng.*, Camden Terrace, Newtown.
1859		Watt, Charles, New Pitt-street.
1874		Watt, John B., The Hon., M.L.C., 104, Macleay-street.
1876		Waugh, Isaac, M.B., M.C., *T.C.D.*, Parramatta.
1876		Webster, A. S., Union Club.
1867		Weigall, Albert Bythesea, B.A. *Oxon.*, M.A. *Syd.*, Head Master of the Sydney Grammar School, College-street.
1874		White, Rev. James S., M.A., LL.D., *Syd.*, Gowrie, Singleton.
1875		White, Hon. James, M.L.C., Cranbrook, Double Bay.
1876		Wilson, F. H., Newtown.
1876		Windeyer, Hon. W. C., M.A., M.L.A., *Syd.*, King-street.
1876		Wise, George Foster, Immigration Office, Hyde Park.
1874		Wilkinson, C. S., Government Geologist, Department of Mines.
1876		Wilkinson, Henry Toller, Department of Mines.
1862		Williams, J. P., New Pitt-street.
1876		Williams, Percy, Treasury.
1873		Wood, Harrie, Under Secretary for Mines, Department of Mines.
1874		Woodgate, E., Parramatta.
1876		Woolrych, F. B. W., 138, Castlereagh-street.
1872		Wright, Horatio, G. A., M.R.C.S., *Eng.*, Wynyard Square.

Honorary Members.

Elected, August, 1875.

Agnew, Dr., Hon. Secretary, Royal Society of Tasmania, Hobart Town.

Barlee, The Hon. F., Colonial Secretary of Western Australia, Perth.

Bernays, Lewis A., F.L.S., Vice-President of the Queensland Acclimatization Society, Brisbane.

Ellery, Robert F., F.R.S., F.R.A.S., Government Astronomer of Victoria, Melbourne.

Gregory, Augustus Charles, F.R.G.S., Surveyor General of Queensland, Brisbane.

Haast, Dr. Julius von, Ph. D., F.R.S., F.G.S., Government Geologist and Director of the Canterbury Museum, New Zealand.

Hector, James, C.M.G., M.D., F.R.S., Director of the Colonial Museum and Geological Survey of New Zealand, Wellington.

M'Coy, Frederick, F.G.S., Hon. F.C.P.S., C.M.Z.S., Professor of Natural Science in the Melbourne University, Government Palæontologist, and Director of the National Museum, Melbourne.

Müller, Baron Ferdinand von, C.M.G., M.D., Ph. D., F.R.S., F.L.S., Government Botanist, Melbourne.

Schomburgh, Dr., Director of the Botanic Gardens, Adelaide, South Australia.

Waterhouse, F. G., F.G.S., C.M.Z.S., Curator of the Museum, Adelaide, South Australia.

Woods, Rev. Julian E. Tenison, F.G.S., F.R.G.S., Hon. Mem. Roy. Soc., Vic., Hobart Town, Tasmania.

Elected, December 6, 1876.

Cockle, His Honor Sir James, Chief Justice, M.A., F.R.S., Brisbane, Queensland.

De Koninck, Prof., M.D., Liège, Belgium.

Obituary, 1876.

Elected.

1876. Cameron, Ewen, Balmain.

1876. Osborne, James, Wollongong.

1874. Raymond, L. C., Union Bank.

1876. Cameron, A. R., M.D., Richmond.

ANNIVERSARY ADDRESS,

Delivered to the Royal Society, 17th May, 1876, by Rev. W. B. Clarke, *M.A., F.R.S., F.G.S., &c., Vice-President.*

ERRATA SLIP.

For the correction of errors, this slip should be filled up and returned to the Hon. Secretaries.

Corrected Address.

Name ......

Titles, &c. ....

Address ...

....

Date

but I am equally contented to have personal ...
continuation of the blessings now being showered upon us.

A

ANNIVERSARY ADDRESS,

Delivered to the Royal Society, 17th May, 1876, by REV. W. B. CLARKE, *M.A., F.R.S., F.G.S., &c., Vice-President.*

GENTLEMEN,

On the last Anniversary I ventured to draw somewhat largely on your patience by a discussion of two important topics which required a considerable amount of research and made it necessary for me to detain you somewhat longer than usual. To-night I propose to confine myself to the Society itself, and to what may be suggested by the events of the period that has elapsed since I last addressed you.

It is my first duty to mention the Conversazione which was held on the 3rd instant, and was, I understand, a great success. The multiplicity of interesting objects exhibited, and the explanations afforded by the Astronomer and others, gratified a company of three hundred persons, many of whom were the guests of the Society. It was unfortunate that several ladies who had graced the room with their presence suffered from the heavy rain that fell as they returned from the assembly, but after the alarming dryness that had so long threatened and at last had begun to create fears of a continuous drought, they could scarcely complain of what was an undoubted blessing to thousands in the land. I regret that I was not well enough to attend, but at the same time I confess I was warned early in the day by the appearance of the sky, and recrossed the harbour before the hour of meeting.

To-night I have not been enabled to exercise similar caution, but I am equally contented to have personal experience of the continuation of the blessings now being showered upon us.

You have heard from the Treasurer what is our pecuniary condition. Considering the expenses which were incurred for furniture and other unavoidable demands upon us in the form of rent and other necessary obligations, it would seem that the Society's finances are in a satisfactory state; as the bank balance is now somewhat in advance of what it was in May, 1875, whilst the assets exceed the liabilities. But in consideration of future contingencies, of which I will speak presently, economy will have to be used if we are to continue as a self-supporting body.

It is a great mishap that so many former members, some of whom were included in our last year's registration, should have induced the Council to put in force a regulation of the Society which, after notice given at the last Anniversary and not responded to, required the removal of their names from the list.

I express my regret at such necessity; but under our present constitution, not only was the measure justifiable, but it must be apparent to each of us that to join any Society which must be self-supporting, on a pledge implied by the rules of election, and to obtain membership by the implied condition of a small annual contribution, and then to ignore not only the obligation itself but continued reminders of it, is suicidal to the respect due to those who regard a "debt of honor" as imperative as any ordinary obligation in life. And it is also plain, that if we all acted in this way the Society itself would collapse by an act of general bankruptcy.

I am glad, however, to find that notwithstanding this secession and additional losses by death, our numbers are still on the increase, and the roll of members now contains 170 names. Forty new members have been elected since the last Anniversary, and there are some fresh ones elected this evening, and others coming forward.

Having got over this difficulty, and having, as our statistics show, met the demands consequent on the advantages derivable from our better arrangements in respect of house accommodation and

of charges for library and furniture, we have good reason for the conviction that the existence of the Society. is strengthened and its further progress assured.

But, gentlemen, we must not let these considerations suffice.

A question might arise—"*cui bono?*" Why are we associated at all? What are our objects? What are our designs? It can, however, hardly be expected that I should again give answer to such inquiries. If we are not of use to each other, nor to the community at large, it would save a great deal of trouble to some of us if we came to a decision to dissolve and retire from these gatherings altogether.

I do not so miscalculate your wishes and views as to agree in such a determination. As I have frequently said before, so I now repeat, that our objects are praiseworthy, and that our endeavours to maintain and occupy a respectable position in the social and intellectual life of the Colony in which we dwell, are deserving of support not only within, but beyond the horizon to which we stretch our expectations. For myself, and may I not add for all of you, I would venture to express a renewed hope, humble as is our present position in the great assemblage of men who are devoting their best energies to the advancement of learning and what is technically called science, that hereafter our Society may expand and increase till it shall be acknowledged to have attained a right, on the score of its usefulness, to the suffrages and liberal support of future generations. To those who go with me in such an aspiration, the words in which we might best express our thoughts would be, "*Esto perpetua.*"

Yet our duty now is clear—not to rest in expectations of the future, but to be diligent and thoughtful in the necessary duties of the present. The suggestions of others and my own agreement with them, lead me, therefore, now to make a distinct allusion and appeal on what is at this time needful to be considered.

We have already elected, to the satisfaction of those who have been so elected, into the rank of Honorary members, many gen-

tlemen distinguished for their attainments and recognized position in the fields of science in other Colonies, who would not so willingly have joined our Society had they not been assured that, in so doing, they become members of a body that has in itself not only some vitality, but is active and vigorous.

As our foreign associates have conferred some dignity upon us, let us not forget that we are expected to show that we do not forget our obligations to them and to ourselves.

Thinking over what I am satisfied would be wise and profitable, and what may perhaps not be very difficult to obtain, I propose to you to apply for a Charter. It may be true that at present we have very little property; and if that is a fatal objection, the wish for incorporation may at this moment be premature.

But the most renowned of Societies in Great Britain had as small a beginning as our own; and its incorporation has made it an institution in the land to which it is now reckoned a chief honor to belong;* and in a less degree, but measured in proportion to the smallness of the population of this country, elections to our Society would be then considered not so much a mere temporary contribution to our treasury, as a significant token of respect for such as are "wise in their generation," and anxious for its advancement.

Placing before you, gentlemen, this suggestion for your further consideration, I would now appeal to you on a subject which is equally deserving of attention, and which is wholly in your power, whatever becomes of support from without.

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* When this allusion to the Royal Society of London was made, the author of the Address did not know that he had been selected by the Council of that Society for election to a Fellowship, which took place on 1st June, a fortnight after the delivery of the Address. This circumstance would not here be noticed in this place were it not (as afterwards transpired), that one of the grounds of recommendation for election was the following:—

"4. Important part taken in the re-founding of the Royal Society of New South Wales, and in the promotion of scientific knowledge in the Colony."

It may be satisfactory to the members of this Society to have thus shared in the honor conferred on one of their members, and to have such evidence of the interest taken in our proceedings by the leading Society in England.

You cannot but have noticed that the actual work done in our Society has fallen upon a few only of its members.

It has been suggested that there would be more contributors to our Transactions if those whose attention has been turned to any given subject, whether of a scientific, a literary, or any other class, were associated together in Sections or Committees. It is surmised that in such a case men who could now enlighten us on various interesting subjects might in notices, however brief, fill up gaps left in discussions by their fellow-members who sometimes in discursive essays have left unnoticed many apparently trifling, but really important, facts or suggestions.

It is not an easy task (I speak from experience) to discuss any topic with the conviction that nothing more remains to be said. And on those particular subjects which especially pertain to the objects set forth in our Fundamental Rules, many are the observations which have been made by different persons, which by such a sectional arrangement as is suggested would doubtless find a place in the record of our proceedings.

Short notes might often contain materials for long meditation and inquiry, and as the Council of the Society has authority to determine what shall or what shall not be read at our monthly meetings, no great mischief would eventually be done, even if such communications as have been alluded to might, perchance, contain useless or indefensible matter. Such would, undoubtedly, be put out of the way of public recognition.

All this is, however, only suggestive on my part; but I recommend it to the consideration of all who are sincerely and heartily interested in the progress of the Royal Society.

There are, it may be, thousands of facts of apparently little importance at the moment of observation—or they may be observed by men unused to scientific, or, as the term is, philosophical inferences, which nevertheless are deserving of being registered, as either bearing on some past discussion or leading to some future application. This kind of contribution to our work would be happily brought into the common garner by the

device of small Committees, who would take in charge the collection of all matters bearing on any division of the subject for the illustration of which they would be thus specially set apart. The humblest contributor would in this way find his observations not lost, but probably utilized when recorded in what I am glad to find has at last been commenced,—viz., the *Proceedings* of our Society.

A similar consideration in relation to scientific progress has been expressed by thinkers at Home, in much stronger terms than I have ventured to employ. For instance, a writer in the *Geological Magazine* for January, 1876, has set before his readers some powerful arguments as to the way in which particular sciences must be cultivated hereafter. As his remarks bear upon some of those just made by myself, and are applicable to other subjects as well, I will quote one or two: "If," says the author, "the geologist wishes now-a-days to increase our general stock of knowledge, he cannot study in detail rock formations and palæontology, nor can he take up palæontology as a whole; he must devote himself particularly to one or other of the great classes of animals or to plants whose remains are preserved to us in a fossil state."

"The testimony of a man who would undertake to name a collection of igneous rocks, and at the same time undertake the identification of a series of fossil bones, shells, corals, or other organic remains, would be received with a certain amount of caution."

Again, "As an illustration, one would be surprised to hear that Professor Ramsay was about to describe a new species of fossil bird, or that Professor Huxley had elucidated the stratigraphical relations of the Devonian rocks; that Professor Prestwich would report on the affinities of Graptolites, or that Mr. Etheridge had undertaken the microscopical examination of igneous rocks. And yet each one would naturally be acquainted with the general results of study in each department of geology."

Now, although these quotations appertain to the divisions of work in building up of one science—they may be applied with tenfold force to divisions of study and labour in the whole range of topics included in the aims of such a Society as ours,—though it be chiefly directed towards the study of the physical history of Australia. One man sees one thing, another man observes another thing. When these separate parts are brought together, all of them assist towards completion of the whole object. The manufacture of a single pin requires numerous skilled workmen, and so in any science to do the work effectually there are required numerous observers and skilful application of principles. If, therefore, there be any member of this Society who can contribute to any particular branch of study, let him associate himself with others in mutual investigations, and we shall then realize the Sectional or Committee arrangement proposed.

I know there are with us several good Astronomers, some good Botanists, some clever Mathematicians, Chemists, Surveyors, and Engineers, &c., &c. Now, would not more good come from mutual assistance to each other in the work of our body, if, in each department of science, or art, or literature, facts were brought together from different quarters all tending one way, viz., towards the completion of our knowledge?

There is one other important consideration which ought not to be neglected.

All persons who have entered upon any kind of scientific study know how needful it is to have the fullest information respecting the state of the particular science which they cultivate. And this is well put in the paper from which I have already quoted two passages. "The literature of the science," says the author, "is such a vast subject that before adding to it one must necessarily learn what has been previously done, and whether one is in possession of any facts not made public, or of any explanations or theories not previously suggested. To study the literature of all branches of geological and palœontological research would indeed be a Herculean task. It is true that our standard manuals

and text-books put us in possession of the leading facts and conclusions, but our magazines and journals are ever increasing the number of facts and of observers."

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"And after all, the high-water-mark of thought (as Professor Huxley puts it) consists in dealing with educational, scientific, and philosophical subjects in a broad, general, and interesting way, so that one may get out of the groove in which one's special work lies, and afford time for the consideration of subjects the outcome of special work in all departments of science." [Geological Progress, *Geological Magazine, January*, 1876.]

I would illustrate this by the volume to which I now refer. It is the first of a series, intended to be annual,—a Catalogue with short abstracts of works on Geology, Mineralogy, and Palæontology, published during any given year.* It was undertaken by gentlemen who have long felt the necessity of a record of the kind. This, the first volume, gives a list of publications on the subjects named during the year 1874, and it occupies 378 closely printed pages, together with an index of 19 pages more, each page arranged in three columns, each of which gives forty or fifty distinct articles. Even this, however, is hardly sufficient to embrace everything that was written in 1874, and gives no room for any works preceding that date.

Such then being the case, the members of our Society require the advantages to be found in a good library of scientific and philosophical works; and the Council have been endeavouring to supply it partially by allowing the sum of £30 for the purchase of periodicals. We need, however, more than this small expenditure. If the Government would contribute somewhat liberally for the purpose of starting and supporting a library of such scientific works as our Society requires, it would serve a double purpose; it would enable us to turn its patronage to good account, and would also be a strong argument for the Incorporation before suggested.

* "Geological Record"—edited by William Whitaker, B.A., F.G.S., of the Geological Survey of England.

An application was made nearly two years ago by myself and a member of the present Council to the Minister of Public Instruction respecting a grant for our special purposes, and this application was favourably received; but, in consequence of objections raised by some of our members, the necessary steps were not then taken to bring the matter before the Parliament. The objectors thought it was not right to place this Society on the same footing as a mere School of Arts, which sometimes becomes a circulating library of light literature; but it was altogether forgotten that the Royal Society of Great Britain receives a grant (I believe, yearly) from the Parliament for its general purposes. And I do not doubt that a proper statement of our application would have met with no denial. We may, I think, appeal to-night to such private individuals as may be willing to contribute to our library, works of scientific value in their possession which they could spare, and I have sufficient faith in the kindly disposition of many in this community in relation to the "higher education" as it is called, to believe that our incipient library might, in this way, be gradually increased, though not so efficiently at once as by the Government itself.

Relieved of some of our internal expenses in this way, our own funds might go in another direction in helping to obtain a residence for the Society free of rent, the amount of which could then be employed in necessary wants that would be sure to arise on its establishment and extended undertakings. By the active exertions of our Secretaries a wide correspondence has been opened with kindred Societies in Europe and America, and the greatest desire has been expressed by leading Associations to exchange publications with us.

Messrs. Trübner and Co., of London, have also offered to be our agents in the business of such exchanges, and the President of the Smithsonian Institution in America has not only endorsed the circular on the subject, issued by us last year, but has undertaken to collect publications for our service from the various Societies in the United States and Canada. An abstract of this correspondence has been placed in your hands.

Justice, Sir A. Stephen, C.B., K.C.M.G., now Deputy-Governor of New South Wales.

Mr. Howard Reed arrived in this Colony about 1867, and soon after became a member of this Society. He was the youngest son of Dr. Andrew Reed, and brother of Sir Charles Reed, who for some time had a seat in the Imperial Parliament, and is still, I believe, Chairman of the London Board of Education.

The father of these gentlemen was a man of great benevolence, and had been mainly instrumental in the erection of no less than six hospitals and asylums in England.

The subject of our notice chose Agriculture as his pursuit, and to his exertions the Agricultural Society of New South Wales is mainly indebted for its existence. He was also connected with the Press in England and this Colony, and his contributions to various journals have elicited the respectful attention of numerous readers. After an illness of some months' duration Mr. Reed died on 23rd October, at the age of forty-eight. He did not contribute any written paper to our Transactions, but he took part in our oral discussions.

A third loss by death occurred in the death of Dr. John Pierce, of Maitland, whose membership dates from 1873; but, as I have been unable to learn any particulars of his career, I content myself with recording his decease.

Mr. W. Hovell, of Goulburn, commonly called Captain Hovell, as in early life he had been a commander in the mercantile marine, joined the Society in 1868. He was associated with Mr. Hamilton Hume in the exploration of the country to the south and south-west. He was with Mr. Hume when he discovered the country beyond the Murrumbidgee River, in 1824. An expedition having been projected by Sir Thomas Brisbane, the then Governor, to traverse the land from Wilson's Promontory to Sydney, Hume and Hovell shared the cost of the expedition which they undertook; but their journey was made from Lake George to Western Port, and the exit was actually about Geelong. Mr. Hume's name was given to the upper part of the

Murray, which they jointly discovered, and in after years this gave rise to a controversy between the explorers, which, as in many other similar cases, called forth much needless acrimony.

A very fair account of the work done by these "first Overlanders," as they are named by one of your recently elected Honorary Members, the Rev. Julian E. Tenison Woods, in his "History of the Discovery and Exploration of Australia," gives to Mr. Hume the distinction of leader; and he was so in more senses than one, having first discovered the country round Berrima, at the age of seventeen, in the year 1814, and afterwards Lake Bathurst in 1817, and for these he received a grant of 300 acres of land.

The Murrumbidgee had been discovered by Currie and Ovens in 1823, before Hume and Hovell started on the overland route to Port Phillip, during which the latter two had discovered the Southern Alps and various rivers flowing from them.

Mr. Woods says justly:—"Their expedition was, without doubt, one of the most important made in Australia, as far as the value of the country discovered is concerned. The New South Wales Government fully appreciated this, and Messrs. Hume and Hovell were both rewarded by a grant of land of 1,200 acres each." Mr. Hovell afterwards explored the Western Port district, which they were at first commissioned to visit, and which Hovell fancied he had reached when the party arrived at Port Phillip.

It is not worth our while now to discuss the controversy respecting the share each may have had in first making out any particular part of the country traversed. As their initials were cut on two neighbouring trees not far from what is now Geelong, and, I believe, were not long since recognizable, no doubt can exist that both were sharers in the labour and toil of the whole exploration, Mr. Hovell therefore should have his share of credit. Though the name of "Hume River" was afterwards supplanted by Captain Sturt's name "The Murray," and Hovell's name given by himself to the "Goulburn" still retains the name assigned to it by Hume, yet Mr. Hovell deserves remembrance by ourselves

as one of the pioneers in the great undertaking of opening up a vast territory, a great portion of which is now in the occupation and government of the sister Colony, Victoria, but was for a long time part of New South Wales. Mr. Hovell was born, I believe, about 1785, and Mr. Hume on 18th June, 1797. The former, therefore, was fully 90 years of age, and may be considered in our records, in relation to the late Alexander Berry, as the twin nonagenarian of our Society. Mr. Hume died in April, 1873.

Commodore Goodenough, R.N.

It is impossible to name the late Commodore Goodenough, who joined us shortly after his arrival, without calling to mind the deep feelings which stirred the whole community when the first news of his death accompanied the arrival of his body for interment.

In the short intercourse with him with which some of us were honored, we could not but learn to appreciate the sterling excellencies of his disposition and the disinterestedness of his character, amply illustrated as these have been by the facts related of his death in the discharge of his voluntary efforts as a christian man to conciliate the savages by whom he was treacherously slain.

His merits have been honorably acknowledged by the Sovereign and Country whom he served with success during a period of two-and-thirty years. In May, 1844, he entered the Navy, became captain in May, 1863, and after a distinguished career was decorated with the insignia of C.B. and C.M.G.

It may seem a work of supererogation in me to venture now on any further tribute to his memory; but as he rendered good service to this Colony, especially in relation to the annexation of Fiji, in which he took a prominent part, we seem to have lost one of our best public friends, and such he was in more senses than one.

He now rests in peace between two youthful seamen, each eighteen years of age, belonging to H.M.S. "Pearl" under his com-

mand, who lost their lives in the same calamity, and but a short space from the tomb of a friend of my own and a connexion of the Commodore, Captain Owen Stanley, R.N., who died in command of H.M.S. "Rattlesnake" in 1850, and over whose remains it was my sad duty to officiate. To him also was accorded, as to Commodore Goodenough, a public funeral.

It was a satisfaction to have enrolled in our list of members, though for so short a time, one who was so distinguished as the latter, and who expressed so deep an interest in the welfare of our Society which he had promised to assist by future communications.

As to his professional character it would not become me to venture an opinion. I can do far better by quoting the testimony of a brother officer of equal rank with himself, to whom he had long been known: "As I write these lines," says Captain Moresby (who was here not long since in command of H.M.S. "Basilisk"), "a telegram has arrived announcing the death of Commodore Goodenough, C.B., C.M.G., commanding on the Australian station, by the poisoned arrows of the natives of Santa Cruz Island. I desire to pay my humble tribute of sorrow and admiration to the memory of this man, with whom I am happy in having held a private friendship for twenty-five years. I do not speak of the loss his friends sustain in him; of the generous nature, full of large kindness and the power of sympathy; of the sound, helpful judgment that was ever ready for any call that could be made on it, for this is sacred ground;—I speak of him only as a public man, and would say that, though I have warmly appreciated him all through, as he rose in our service, I never knew his full professional worth till I had the honor of serving under him in Australia.

"Then, his grasp of mind in dealing with a subject, his self-reliance and readiness to take responsibility, his happy way of taking his captains into his confidence, whilst always holding the reins himself, of giving praise liberally where praise was due, and cordial support or advice where either was needed, produced an impression on my mind of greatness in store for him in the future which can now never, alas! be made good. His fine scientific

and sailorlike qualities, his promptitude, his iron nerve, combine with his other gifts to make his loss a national one, and as such it will be doubtless be regarded, and this will be some consolation to his friends; but their best will lie in the knowledge that his pure and devout spirit was ever ready to enter the presence of its Maker."

The death of the Commodore was felt as a serious loss at Home and by the Admiralty and the Naval Service at large, as evidenced by a prospectus of a "Goodenough Memorial Fund," a copy of which lately received from England I lay upon the table, inviting any of our members to subscribe to it who may feel that, in so doing, they are acknowledging the services of one who deserved a memorial such as Plato (*Menexenus*) tells us heathen Greece accorded to the survivors of all who fell in the service of their country; for, as was held by Pericles (Thucyd. II. 34), "they who by their acts had shown true courage should by corresponding acts of gratitude be honored."

There are some interesting circumstances relating to the scene of the late Commodore's martyrdom which may, I trust, not be considered impertinent to mention at this meeting.

Scarcely four years had elapsed since Bishop Patteson, who was well known to the natives of Santa Cruz, and had often been among them, was, with two of his companions, also stricken and slain. "Suddenly, without any previous warning (it is related by one of his biographers) a man rose, and saying, "Have you got anything like this?" let fly an arrow, which was quickly followed by a volley from his seven companions. Mr. Atkin was shot in the left shoulder, whilst of the three Melanesians one of them was wounded slightly, and the other was pierced by no fewer than six arrows. Every arrow had thus taken effect."

Seven years before this, two youths belonging to the Melanesian Mission were slain also at Nupuku, close to Santa Cruz;* and, if I mistake not, since then other victims perished in the

* Sketches of the life of Bishop Patteson in Melanesia, p. 185.

same way. History records also other calamities of like kind in the same group of islands.

Captain Carteret, in August, 1767, more than a century before the visit of the "Pearl," experienced the very same hostility and treachery which distinguished the fate of Bishop Patteson and Commodore Goodenough. In the 4th chapter of his Voyage, he gives an "Account of the Discovery of Queen Charlotte Islands, with a description of them, their Inhabitants, and of what happened at Egmont Island." The latter "certainly is," he says, "the same to which the Spaniards have given the name of Santa Cruz, as appears by the accounts which the writers have given of it."

If we compare the statements published respecting the deaths of the Bishop and the Commodore with Carteret's statements, we shall find the same circumstances in each,—too great confidence in the natives, and the greatest jealousy and treacherous conduct on the part of the latter. Bishop Patteson laid great stress, in his "Memorial on the South Sea Labour Traffic," on the cause of evil and death in the Pacific, and quotes the testimony of the commander of a whaling ship to the same effect.

The latter says what the Bishop confirms:—"The natives of these islands would come off in former years, bringing such articles of trade as their islands afford, for which we paid them with hatchets, tobacco, fish-hooks, &c. They trusted us and we trusted them. At times our decks were crowded. This, when slavery commenced, was all to the slaver's advantage, for the natives were easily enticed below, the hatches put on, and the vessel was off. Now no natives come on board the whale-ship, and we in our turn dare not land. Again, we used to carry people from one island to another when they wished it, and they would give us hogs and other articles. This also has been taken advantage of, and the natives carried into slavery instead of home. Should we be wrecked our lives must go for those that have been stolen, and the natives will be condemned and called blood-thirsty, &c., and yet what have the natives done? Not certainly right, but no more than civilized people have done in many cases. I hear they use your name" (*i.e.*, the Bishop's) "to decoy natives from their

islands; and I also hear, from good authority, that they inquire very particularly of the whereabouts of the Southern Cross." —*Memorial*, p. 201.

Doubtless, this testimony to the consequences of a recent nefarious traffic is not the whole explanation of the conduct of natives of certain islands, Santa Cruz in particular. For, more than a century ago, Captain Carteret found the same characteristics in the inhabitants of Santa Cruz as were exhibited towards the Bishop and the Commodore when there were no slave-dealers and kidnappers on whom to lay the blame.

But few persons, comparatively, have ever read the narrative of Captain Carteret. At the risk of occupying too much of our time, I cannot resist, with your permission, the reading of a portion of his statement, which has been copied for me at my request.

Extract from Captain Carteret's account of the discovery of Queen Charlotte's Islands, with a description of them, their inhabitants, and of what happened at Egmont Island—[August 1767.]

"The next morning, therefore, as soon as it was light, I dispatched the master, with fifteen men, in the cutter, well armed and provided, to examine the coast to the westward, our present situation being on the lee of the island, for a place where we might more conveniently be supplied with wood and water, and, at the same time, procure some refreshments for the sick and lay the ship by the stern to examine and stop the leak. I gave him some beads, ribbons, and other trifles, which by chance I happened to have on board, to conciliate the good-will of the natives, if he should happen to meet with any of them; but at the same time enjoined him to run no risk, and gave him particular orders immediately to return to the ship if any number of canoes should approach him which might bring on hostilities; and if he should meet the Indians in small parties, either at sea or upon shore, to treat them with all possible kindness, so as to establish a friendly intercourse with them; charging him on no account to leave the boat himself nor to suffer more than two men to go on shore at

a time, while the rest stood ready for their defence; recommending to him, in the strongest terms, an application to his duty, without regarding any other object, as the finding a proper place for the ship was of the utmost importance to us all; and conjuring him to return as soon as this service should be performed, with all possible speed.

"Soon after I had dispatched the cutter on this expedition, I sent the long boat with ten men on board well armed to the shore, who before 8 o'clock brought off a tun of water. About 9 I sent her off again, but soon after seeing some of the natives advancing along the shore towards the place where the men landed, I made the signal for them to return, not knowing to what number they would be exposed, and having no boat to send off with assistance if they should be attacked.

"Our men had not long returned on board, when we saw three of the natives sit down under the trees abreast of the ship. As they continued there gazing at us till the afternoon, as soon as the cutter came in sight, not caring that both the boats should be absent at the same time, I sent my lieutenant in the longboat with a few beads, ribbons, and trinkets, to endeavour to establish some kind of intercourse with them, and by their means with the rest of the inhabitants; these men, however, before the boat could reach the shore, quitted their station, and proceeded along the beach. As the trees would soon prevent their being seen by our people, who were making towards the land, we kept our eyes fixed upon them from the ship, and very soon perceived that they were met by three others. After some conversation, the first three went on, and those who met them proceeded towards the boat with a hasty pace. Upon this I made the signal to the lieutenant to be upon his guard, and as soon as he saw the Indians, observing that they were more than three, he backed the boat in to the shore, and making signs of friendship, held up to them the beads and ribbons which I had given him as presents, our people at the same time carefully concealing their arms. The Indians, however, taking no notice of the beads and ribbons,

resolutely advanced within bow-shot, and then suddenly discharged their arrows, which happily went over the boat without doing any mischief; they did not prepare for a second discharge but instantly ran away into the woods, and our people discharged some muskets after them, but none of them were wounded by the shot. Soon after this happened the cutter came under the ship's side, and the first person that I particularly noticed was the master, with three arrows sticking in his body. No other evidence was necessary to convict him of having acted contrary to my orders, which appeared more fully from his own account of the matter, which it is reasonable to suppose was as favourable to himself as he could make it. He said that, having seen some Indian houses with only five or six of the inhabitants, at a place about fourteen or fifteen miles to the westward of the ship's station, where he had sounded some bays, he came to a grappling, and veered the boat to the beach, where he landed with four men, armed with muskets and pistols; that the Indians at first were afraid of him, and retired, but that soon after they came down to him, and he gave them some beads and other trifles with which they seemed to be much pleased; that he then made signs to them for some cocoa-nuts, which they brought him, and with great appearance of friendship and hospitality gave him a broiled fish and some boiled yams; that he then proceeded with his party to the houses, which, he said, were not more than fifteen or twenty yards from the water-side, and soon after saw a great number of canoes coming round the western point of the bay, and many Indians among the trees; that, being alarmed at these appearances, he hastily left the house where they had been received, and with the men, made the best of his way towards the boat; but that, before he could get on board, the Indians attacked, as well those that were with him as those that were in the boat, both from the canoes and the shore. Their number, he said, was between 300 and 400; their weapons were bows and arrows—the bows were 6 feet 5 inches long, and the arrows 4 feet, which they discharged in platoons as regularly as the best disciplined troops in Europe. That it being necessary to defend himself and his people when

they were thus attacked, they fired among the Indians to favour their getting into their boat, and did great execution, killing many and wounding more. That they were not however discouraged, but continued to press forward, still discharging their arrows by platoons in almost one continued flight; that the grappling being foul occasioned a delay in hauling off the boat, during which time he and half of the boat's crew were desperately wounded; that at last they cut the rope, and ran under their foresail, still keeping up their fire with blunderbusses, each loaded with 8 or 10 pistol balls, which the Indians returned with their arrows, those on shore wading after them breast-high into the sea. When they had got clear of these the canoes pursued them with great fortitude and vigour till one of them was sunk and the numbers on board the rest greatly reduced by the fire, and then they returned to the shore. Such was the story of the master, who, with three of my best seamen, died some time afterwards of the wounds they had received; but, culpable as he appears to have been by his own account, he appears to have been still more so by the testimony of those who survived him. They said that the Indians behaved with the greatest confidence and friendship till he gave them just cause of offence by ordering the people that were with him, who had been regaled in one of their houses, to cut down a cocoa-nut tree, and insisting upon the execution of his order notwithstanding the displeasure which the Indians strongly expressed upon the occasion; as soon as the tree fell all of them except one, who seemed to be a person of authority, went away, and in a short time a great number of them were observed to draw together in a body among the trees by a midshipman who was one of the party that were on shore, and who immediately acquainted the master with what he had seen, and told him that from the behaviour of the people he imagined an attack was intended; that the master made light of the intelligence, and, instead of repairing immediately to the boat, as he was urged to do, fired one of his pistols at a mark; that the Indian, who had till that time continued with them, then left them abruptly and joined the body in the wood; that

the master, even after this, by an infatuation that is altogether unaccountable, continued to trifle away his time on shore, and did not attempt to recover the boat till the attack was begun.

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"The next morning, the weather being fine, we veered the ship close in shore with a spring upon our cable, so that we brought our broadside to bear upon the watering-place for the protection of the boats that were to be employed there. As there was reason to suppose that the natives, whom we had seen among the trees the night before, were not now far distant, I fired a couple of shots into the wood before I sent the waterers ashore; I also sent the lieutenant in the cutter well manned and armed with the boat that carried them, and ordered him and his people to keep on board and be close to the beach to cover the watering boat while she was loading, and to keep discharging muskets into the wood on each side of the party that were filling the water. These orders were well executed. The beach was steep so that the boats could lie close to the people that were at work; and the lieutenant from the cutter fired three or four volleys of small arms into the woods before any of the men went on shore, and none of the natives appearing, the waterers landed and went to work. But notwithstanding all these precautions, before they had been on shore a quarter of an hour, a flight of arrows was discharged among them, one of which dangerously wounded a man that was filling water in the breast, and another stuck into a bareca on which Mr. Pitcairn was sitting. The people on board the cutter immediately fired several volleys of small arms into that part of the wood from which the arrows came, and I recalled the boats that I might effectually drive the Indians from their ambuscades with grape-shot from the ship's guns. When the boats and people were on board we began to fire, and soon after saw about two hundred men rush out of the woods and run along the beach with the utmost precipitation. We judged the coast to be now effectually cleared, but in a little time we perceived that a great number had got together on the westernmost point of the bay, where they probably thought themselves beyond our

reach. To convince them, therefore of the contrary, I ordered a gun to be fired at them with round shot; the ball just grazing the water rose again and fell into the middle of them, upon which they dispersed with great hurry and confusion, and we saw no more of them. After this we watered without any further molestation, but all the while our boats were on shore we had the precaution to keep firing the ship's guns into the wood on both sides of them, and the cutter—which lay close to the beach, as she did before—kept up a constant fire of small arms in platoons at the same time. As we saw none of the natives during all this firing, we should have thought that none of them had ventured back into the wood, if our people had not reported that they heard groans from several parts of it, like those of dying men.

"The master was dying of the wounds he received in his quarrel with the Indians; the lieutenant also was very ill; the gunner and thirty of my men incapable of duty, among whom were seven of the most vigorous and healthy that had been wounded with the master, and three of them mortally, and there was no hope of obtaining such refreshments as we most needed in this place. These were discouraging circumstances, and not only put an end to my hopes of prosecuting the voyage farther to the southward but greatly dispirited the people. Except myself, the master, and the lieutenant, there was nobody on board capable of navigating the ship home; the master was known to be a dying man, and the recovery of myself and the lieutenant was very doubtful. Not being in a condition to risk the loss of any more of the few men who were capable of doing duty, I weighed anchor at daybreak on Monday the 17th, and stood along the shore for that part of the island to which I had sent the cutter. To the island I had given the name of Egmont Island, in honor of the Earl; it certainly is the same to which the Spaniards have given the name of Santa Cruz, as appears by the accounts which the writers have given of it, and I called the place in which we had lain Swallow Bay. When we had proceeded about three leagues from the harbour we opened the bay

where the cutter had been attacked by the Indians, to which, for that reason, we gave the name of Bloody Bay. In this bay is a small rivulet of fresh water, and here we saw many houses regularly built; close to the waterside stood one much longer than any of the rest, which seemed to be a kind of common hall or council-house, and was neatly built and thatched. This was the building in which our people had been received who were on shore here with the master, and they told me both the sides and floor were lined with a kind of fine matting, and a great number of arrows, made up into bundles, were hung up in it ready for use. They told me also that at this placo there were many gardens, or plantations, which were enclosed by a fence of stone, and planted with cocoa-nut trees, bananas, plantains, yams, and other vegetables; the cocoa-nut trees we saw from the ship, in great numbers, among the houses of the village. About three miles to the westward of this town we saw another of considerable extent, in the front of which, next to the waterside, there was a breastwork of stone, about 4 feet 6 inches high, not in a straight line, but in angles, like a fortification; and there is great reason to suppose, from the weapons of these people, and their military courage, which must in great measure be the effect of habit, that they have frequent wars among themselves. As we proceeded westward from this place we found, at the distance of two or three miles, a small bight, forming a kind of bay, in which a river empties itself. Upon taking a view of this river from the masthead, it appeared to run very far into the country, and at the entrance, at least, to be navigable for small vessels. This river we called Granville's River, and to the westward of it is a point, to which we gave the name of Ferrer's Point. From this point the land forms a large bay, and near it is a town of great extent, which seemed to swarm like a beehive: an incredible multitude came out of it as the ship passed by, holding something in their hands which looked like a wisp of green grass, with which they seemed to stroke each other, at the same time dancing or running in a ring. About seven miles to the westward of Point Ferrers is another, that was called Carteret Point, from which a reef of

rocks that appears above water runs out to a distance of about a cable's length. Upon this point we saw a large canoe, with an awning or shade built over it; and a little to the westward, another large town, fronted, and probably surrounded, with a breastwork of stone like the last; here also the people thronged to the beach as the ship was passing, and performed the same kind of circular dance. After a little time they launched several canoes and made towards us, upon which we lay to, that they might have time to come up, and we conceived great hopes that we should prevail upon them to come on board, but when they came near enough to have a more distinct view of us they lay upon their paddles and gazed at us, but seemed to have no design of advancing further, and therefore we made sail and left them behind us. Having hauled round this cape, we found the land trend to the southward, and we continued to stand along the shore till we opened the western passage into the lagoon between Trevanion's Island and the main land. In this place, both the main and the island appeared to be one continued town, and the inhabitants were innumerable. We sent a boat to examine this entrance or passage, and found the bottom to be coral and rock, with very irregular soundings over it. As soon as the natives saw the boat leave the ship they sent off several armed canoes to attack her; the first that came within bow-shot discharged their arrows at the people on board, who, being ready, fired a volley, by which one of the Indians was killed and another wounded; at the same time we fired a great gun from the ship, loaded with grape shot, among them, upon which they all pulled back to the shore with great precipitation, except the canoe which began the attack, and that being secured by the boat's crew, with the wounded man in her, was brought to the ship. I immediately ordered the Indian to be taken on board, and the surgeon to examine his wounds; it appeared that one shot had gone through his head, and that his arm was broken by another. The surgeon was of opinion that the wound in his head was mortal, I therefore ordered him to be put again into his canoe, and, notwithstanding his condition, he paddled away towards the shore. He was a young man, with a

woolly head like that of the negroes, and a small beard, but he was well-featured, and not so black as the natives of Guinea; he was of the common stature, and, like all the rest of the people whom we had seen upon the island, quite naked. His canoe was very small, and of rude workmanship—being nothing more than part of the trunk of a tree made hollow; it had, however, an outrigger, but none of them had sails.

"The inhabitants of Egmont Island, whose persons have been described already, are extremely nimble, vigorous, and active, and seem to be almost as well qualified to live in the water as upon the land, for they were in and out of their canoes almost every minute. The canoes that came out against us from the west end of the island were all like that which our people brought on board, and might probably, upon occasion, carry about a dozen men, though three or four managed them with amazing dexterity. We saw, however, others of a larger size upon the beach, with awnings or shades over them.

"We got two of their bows, and a bundle of their arrows, from the canoe that was taken with the wounded man; and with these weapons they do execution at an incredible distance. One of them went through the boat's washboard, and dangerously wounded a midshipman in the thigh. Their arrows were pointed with flint, and we saw among them no appearance of any metal."

This, then, is what occurred in 1767. Nor is this all. In 1568, two centuries before (within a year), Mendăna, who about that time discovered Santa Cruz, and all subsequent navigators, whether French or English, found the inhabitants of the great island groups and archipelagoes of that part of the Pacific, ferocious, treacherous, and bloodthirsty; so that conjectures as to the immediate cause of any given catastrophe may be attributed in part to the sudden excitement of the natives or to some imprudence on the part of visitors, as well as to the *utu*, or retaliation on past offenders. In Carteret's account this is distinctly stated; and it is impossible to say in what way the Bishop and the Commodore might have infracted some rule unknown to them. That

the people of Santa Cruz have understanding of the art of defence as well as of attack is shown also by Carteret, who describes their breast-works, and the mode of delivery of their arrow shots in true military style. Captain Moresby, R.N., who visited Santa Cruz in H.M.S. "Basilisk," before the visit of the "Pearl" and after the death of the Bishop, incidently confirms much that was noticed by Carteret respecting these breast-works and the weapons of offence. He says:—"The village" (in Byron's Bay, mentioned by Carteret) "is fortified by low coral walls, breast-high, the openings in which are overlapped by other walls, calculated to throw an attacking party into some confusion."

One thing has puzzled many persons in reference to the treatment of Bishop Patteson after his death. Instead of disposing of the body as cannibals might have done, they wrapped it in native matting, tied at the neck and ankles, thrust a palm frond into the breast, with five knots tied in it—and then placed it in a canoe which was floated away. [See "Sketches, &c.," p. 186.] Mr. Atkin who was wounded at the same time with the Bishop and afterwards died, is recorded to have heard one of the natives say, the Bishop was *tapu*. If this word means the same as *tabu* in Tonga, then it would appear they knew who in some degree the Bishop was, and though they slew him respected his character. They even "put a small kit of yams into the boat upon which they fired." (p. 192.)

It is certain that the visit of the "Basilisk" was of a peaceful character, for Captain Moresby says:—"The friendliness of these natives to us was remarkable, and I have deeply regretted to learn that some difficulty has since arisen between them and H.M. schooner, 'Sandfly,' during her late visit to this place, resulting in the loss of numerous native lives." "An event of this kind," he adds, "is to be regretted, not so much for the present effect, as for the misunderstanding, the want of confidence, and the revengeful feeling it produces in the future."

As Captain Moresby thus alludes to H.M.S. "Sandfly," I have been induced to look up the accounts respecting her adventure, and the following particulars have been met with:—

"The 'Sandfly,' on 14th September, 1874, was at Tapoua, or Edgcombe Island of Carteret, which was surveyed by Captain Moresby, and in which he discovered a very fine harbour, and named it after the 'Basilisk.' The natives appeared friendly but were not armed. On the 17th about thirty canoes came off, well provided with bows and poisoned arrows. The people in them were friendly till dinner-time, when the deck of the 'Sandfly' was nearly cleared; the savages then commenced firing with the arrows in some of the canoes ahead of the ship, which was stopped by a discharge of rifles. The commander of the 'Sandfly' then left the ship to give chase in his gig, and was again fired at with arrows, and after a few rounds from the rifles to clear the bush, the gig went in to the shore, and towed out nine canoes: boats were manned and two villages were burned, and all the canoes destroyed. On the 19th, a man who could speak English, and was a survivor of a vessel that had had an affray at Vanikoro, where the captain was attacked and wounded as well as himself, came off to the 'Sandfly' stating that their boat had drifted on shore owing to the tide at Tapoua, where the captain died and was buried.

"On 20th September, the 'Sandfly' anchored at Santa Cruz. The natives here came off in great numbers, well armed with bows and poisoned arrows, and made an attack on the vessel. This was repulsed, and two villages and several canoes were destroyed by the ship."

This account was first stated in the Sydney *Herald* of 11th December, 1874, but in that journal of 31st October, 1874, there is a memorandum of the reported massacre of the crew of the "Lapwing," of Auckland, which had been attacked at the island of Tafosia, one of the Santa Cruz group, stating that the whole of the crew, save one Tanna man, had been killed, and that the vessel had been destroyed by fire. It seems the "Lapwing" (according to the captain of the "Bruce") ran short of provisions, and the mate and boat's crew proceeded to the shore to obtain some, when the natives attacked the boat,

killed the men in her, seized the vessel and murdered the master and rest of the crew, the latter being Kanakas. This looks certainly like another version of the statement made by the native man at Tapoua just related, especially as the same memorandum mentions that H.M.S. "Sandfly" had been attacked, and a smart engagement had taken place, by which the natives had suffered loss.

Two things seem to point out that, if these accounts relate to the same vessel, she bore two names; for in the "Sandfly's" report the vessel that the Vanikoro man belonged to was the "Tortue," which sailed under French colours, and the "Lapwing" is stated to have been reported from Noumea, in New Caledonia, to Messrs. Montefiore, of Sydney. Whatever happened, it is quite certain that the Santa Cruz people had committed an aggression on an English ship of war, and had been punished severely between the visit of the "Basilisk" in August, 1872, and that of the "Pearl" in August, 1875.

The death of Commodore Goodenough was probably a revenge on the "Sandfly"; the attack on the latter, and the death of the Bishop, perhaps the result of feelings excited by the labour traffic; but the reception of Captain Morseby was friendly, whilst the fact is that "kill-kill" vessels, as certain labour crafts are called by the natives, were objects of aversion, and that if we are to trust an eye-witness (see Brooke's Journal, "Mission Life, 1872, p. 7"), very properly so. Mr. Brooke says, "natives in the island of Florida were captured merely for the sake of their skulls, with which payment was made to the chiefs of neighbouring islands; and canoes on coming alongside a vessel were upset, and their occupants dispatched whilst vainly striving to escape to shore. The victims were first belaboured with oars, then fallen upon with tomahawks and finally beheaded, their heads being taken on board, and their bodies thrown to the sharks."

Mr. Brooke, whose words are thus quoted, says that in the course of two or three months in that one island alone he had

seen eighteen persons murdered in cold blood, and fifty taken away either by force or under false pretences.

If any one think such references too discursive for an Address to the members of a Society belonging to a country on the shores of the ocean on which such atrocities as have been mentioned have been committed, let me explain that I have considered them not altogether intrusive in a discourse to Christian gentlemen; and with one further remark I will conclude.

It is said that France intends to take possession of Santa Cruz. If it be so, and the intention be to civilize and christianise its population, well and good: but it would, I think, be a more suitable occupation if England (putting aside all political or territorial considerations) undertook the task of carrying her enterprise in colonization into effect by endeavouring to reclaim the savages of the Archipelagoes which have, by martyrdoms and massacres innumerable of British subjects, given her the responsibility as well as the prestige of furthering the cause of peace and evangelization; and I doubt not that those deaths which we have deplored will eventually lead as it were to the opening of a new vista in the dark prospects of Melanesian heathendom. It cannot be beyond the good wishes of ourselves, who belong to a Society which derives its title, by permission, from the Sovereign, who is again by the will of the nation styled "Defender of the Faith," to desire that Her Majesty may enrol among her subjects thousands snatched from slavery and emancipated from the dominion of rites and customs that have no other support than ignorance, brutality, and the worst passions of mankind.

Society's Work.

The work done by the Society during the last year is represented by the following list of contributions:—

May 12.—Anniversary Address, on Deep Sea Soundings, and the Geology of New Caledonia. By Rev. W. B. Clarke, M.A., F.G.S.

June 2.—Facts in American Mining. By S. L. Bensusan, Esq.

July 7.—On the Stanniferous Deposits of Tasmania. By S. H. Wintle, Esq. [Communicated by Rev. W. B. Clarke.]

August 7.—On Sydney Water Supply by Gravitation. By James Manning, Esq.

September 1.—Appendix to the preceding.

October 6.—Second paper on Supply by Gravitation. By James Manning, Esq.

November 3.—Scientific Notes in America and Europe. By H. C. Russell, Esq., F.R.A.S.

December 1.—Supplementary Notice on Deep Sea Soundings. By Rev. W. B. Clarke, M.A., F.G.S.

In the instance of our last volume, the delay that has unavoidably occurred in its publication is to be regretted, as it is an improvement on former volumes, containing the Proceedings of our monthly meetings, and two additional papers—one by our active Secretary, Professor Liversidge, on New South Wales Minerals, of which the title was read 9th December, 1874; and another, by Mr. Russell, our Treasurer, being a summary of the Meteorological Observations of the year. These will supply many extra pages to the work. The cause of delay in the completion of the volume is the accumulation of work in the Printing Office, so that others who share with us the good services of that Office have to wait as well as ourselves.

There is an evil in delays of the kind, which is unintended and unavoidable. In the present day, first publication of any new fact gives the right of priority as a discovery. By the kindness of the proprietors of the *Herald* we have been able to prevent any ill effect of the kind arising from irregularity of issue of our Transactions, so far as the authors of papers are concerned; but the members generally have to wait very long for the volumes after they are ready for the Press, owing altogether to the increased amount of business. This is one of many grounds for the desire expressed by numerous persons that a Copyright Act should be passed through Parliament. As the law now is, there is nothing to prevent any unscrupulous person from pirating the opinions or discoveries of living authors, and by skilful use of their words, whilst *omitting all marks of quotation or reference to names*, appropriating what is not their own, and altering

materials so purloined. I speak on this point with some authority, as I have myself suffered in this way; and were not our time too short, I could point out some cases where this species of "picking and stealing" has been a bar to the imparting of further information on matters interesting to the community.

Conclusion.

I have now completed my intention with respect to the materials of this Address. At first, I had proposed to introduce several notices of subjects which though of great interest I have seen fit to leave for other occasions. Allow me, however, to repeat that the chief points which require the Society's attention have reference to our progress.

There are those who have predicted that this Society will die out. At present it is not moribund but alive and active, and if those who ought to join us as working members would only lend us a helping hand I do not fear that we shall not realize the hopes of the most sanguine of us. Why should any of our members refuse to tell us, as briefly as they like, what may be useful to be known? In the arrangement proposed all kinds of information could be employed by the Sectional Committees without disturbing the modesty of the most retiring contributor; and why a mechanic, or a manufacturer, or a traveller, or mere observer, should keep back under some delicacy of feeling which hinders a common object I know not. We are called, no doubt, by a somewhat lofty designation, but we do not presume to consider ourselves of such renown as to make it presumption in any one to do what he can to help on the common work. We do not boast at present of taking a lead in Science or Literature, and if such were the aim of our Association I for one would retire from it at once. Our true position is that of pioneers, sowers, foundation-layers; and in that respect we have assuredly an honorable occupation; and as such, and such only, I have aspired to take a part, somewhat, perchance, too prominent, in occasionally "going-a-head," sometimes scattering a seed for thought here and there—and sometimes adding a pebble to what here-

NOTES ON SOME REMARKABLE ERRORS SHOWN BY THERMOMETERS.

BY H. C. RUSSELL, B.A., F.R.A.S., Government Astronomer.

[*Read before the Royal Society of N.S.W.*, 7 *June*, 1876.]

IN the present day, when so much reliance is placed on thermometers both by scientific and medical men, probably no apology is necessary for bringing before the members of the Royal Society the faults of one or two instruments, when, as in the present case, those faults seem to be quite inexplicable by known conditions affecting the accuracy of thermometers, and to depend upon some unknown relation existing between the mercury and the glass.

I therefore put the following facts on record, in the hope that they may yet be found to be connected with the explanation of some of the extraordinary temperatures that have been published.

For more than five years we have had a first-class dry and wet bulb hygrometer in use at the Observatory; by the side of the dry bulb a standard thermometer has been kept, and always read at the same time as the dry bulb. The difference between them varied very little, two or three tenths of a degree usually, and in some rare cases as much as one degree. Up to the 26th February, this year, we never had reason to suspect the dry bulb of uncertain indications; on that day the maximum temperature rose to 96·4 at or about noon; at 3 p.m., the dry bulb and standard had both fallen to 88·7, and at 9 p.m. to 68·9 and 69·0; next morning they read 69·6 and 69·8, but the following morning the readings were—standard, 64·9; dry bulb, 87·3; showing a difference of 22·4. It was at once inferred that the glass had cracked and let in the air, but as no crack could be seen on careful examination, and it was determined to continue observing it for a time. The observations will be found in Appendix A.

If a glass thermometer cracks, the mercury steadily rises till the tube is full, and it was expected that such would be the case here; but no, the difference steadily *decreased*, and in 35 days it had almost recovered its original condition, being sometimes less than half a degrée; between the 7th and 17th of April the

difference increased to 13·3 degrees, and then fell again. On the 3rd May, and again on the 7th of May, two sudden jumps occurred, and the difference rose to 13·7. Since then it has gradually fallen, except a slight rise May 21, 22. (*See diagram.*)

In the first instance the barometer was steady at about 30 inches, with some minor oscillations, and there has been no barometric oscillation during the whole time which might be supposed equal to produce such effects, and even if there had been, it should have affected all the thermometers alike. At present I can see no satisfactory clue to the explanation of these thermometer excursions. Once before when using a standard, in April 1872, to test another thermometer, the temperature of the water was raised to 210°, and it was found that subsequently, for four days, the standard itself read too low by several tenths of a degree (see Appendix B), and then recovered its normal condition. Here the cause was evident; the glass had expanded, and did not *contract* as fast as it *cooled*. We often find differences also in the readings given by thermometers of known good quality, but these are attributed to difference in sensitiveness arising from thickness of glass, or other causes; where the changes are sudden, as in thermometers on the grass exposed to the effects of radiation, the differences sometimes amount to several degrees. (See Appendix C.) That common thermometers give results differing by several, and in some cases as much as ten degrees, is well known to all who have had much to do with them, and that the glass continues to contract for years after it has been melted is beyond question; for the makers keep thermometers two or three years before graduating them, and even then in many cases they go on contracting. But all the thermometers about which I have made these notes are of the best description, and the comparisons made in England before they were sent out have not been taken without re-examination. All the thermometers we use are compared in air with the standard here.

On examination with the microscope, the dry bulb in question presents two features which must be mentioned; one is a small piece of coloured glass as if lead had been reduced in melting the bulb; the other is a little patch that looks like water inside the bulb. As the bulb is blown by the workman's lungs, this may be condensed water in the bulb, from that source. Whether this can have anything to do with its uncertain readings I do not know, but it is possible that some action may take place between mercury and water under a vacuum.

One other point must be mentioned. Fine glass, such as that used for lenses, if kept untouched for some months and then examined with a microscope, will be found covered with oily-looking specks, which evidently ooze out of the glass, or are formed by the action of moisture on some of its constituents.

With regard to these thermometer changes, there have been found some very remarkable coincidences which should also be placed on record. The first jump in the thermometer was during the 27th of February. On that day at 2·30 p.m., we were visited by a small tidal wave, the result, it would seem, of earthquakes in New Zealand.

From 7th to 17th April we have the next remarkable part of the thermometer curve, and we have also many small tidal waves recorded about the same time.

On the 3rd of May we have the next conspicuous point in the curve, and on that day at 11·30 p.m., another tidal wave is recorded in Sydney and Newcastle, with many minor disturbances about the same time; and on the 7th of May we have the second in magnitude. On that day, at 6·45 p.m., another tidal wave reached Sydney, the result of earthquakes in New Zealand.

Again, on 21st of May, we have another feature in the thermometer curve, and another tidal wave recorded in Sydney harbour at 11·30 p.m. Are these coincidences accidental, or are they consequences of some impulse affecting all alike?

In the diagram the straight line represents the readings of the standard thermometer, reduced to a straight line. The curved line shows the difference between the dry bulb and the standard. At 9 a.m. on each day the gradual decrease in the difference shown day after day in so marked a manner is evident in all the readings, the differences being less at night than in the morning; showing a steady decrease in the gas or other substance in the thermometer which produced the difference.

Sydney Observatory, 7th June, 1876.

A

Readings of Standard and Dry Bulb Thermometers, Sydney Observatory, 1876.

Date.	Time.	Standard.	Dry bulb.	Difference.	Date.	Time.	Standard.	Dry bulb.	Difference.
Feb. 23	9 a.m.	67·7	67·9	0·2	March 9	9 a.m.	73·8	82·7	8·9
" "	3 p.m.	70·1	70·2	0·1	" "	3 p.m.	76·8	85·4	8·6
" "	9 "	64·8	64·8	0·0	" "	9 "	72·3	81·0	8·7
" 24	9 a.m.	72·1	72·1	0·0	" 10	9 a.m.	74·6	82·8	8·2
" "	3 p.m.	74·3	74·3	0·0	" "	3 p.m.	77·8	85·6	7·8
" "	9 "	69·7	70·0	0·3	" "	9 "	73·0	81·0	8·0
" 25	9 a.m.	77·3	77·5	0·2	" 11	9 a.m.	75·6	83·2	7·6
" "	3 p.m.	84·0	84·0	0·0	" "	3 p.m.	78·3	85·4	7·1
" "	9 "	75·0	75·0	0·0	" "	9 "	73·0	80·4	7·4
" 26	9 a.m.	79·4	79·5	0·1	" 12	9 a.m.	76·5	83·8	7·3
" "	3 p.m.	83·7	83·7	0·0	" "	3 p.m.	"	"	"
" "	9 "	68·9	69·0	0·1	" "	9 "	"	"	"
" 27	9 a.m.	69·6	69·8	0·2	" 13	9 a.m.	77·6	83·8	6·2
" "	3 p.m.	"	"	"	" "	3 p.m.	78·5	84·3	5·8
" "	9 "	"	"	"	" "	9 "	72·9	78·8	5·9
" 28	9 a.m.	64·9	87·3	22·4	" 14	9 a.m.	76·9	82·0	5·1
" "	3 p.m.	69·2	90·3	21·1	" "	3 p.m.	76·1	81·3	5·2
" "	9 "	63·6	84·1	20·5	" "	9 "	73·8	79·0	5·2
" 29	9 a.m.	66·3	85·5	19·2	" 15	9 a.m.	78·8	83·4	4·6
" "	3 p.m.	69·9	88·3	18·4	" "	3 p.m.	77·7	82·4	4·7
" "	9 "	64·9	83·1	18·2	" "	9 "	73·3	78·1	4·8
March 1	9 a.m.	68·6	85·9	17·3	" 16	9 a.m.	77·0	81·6	4·6
" "	3 p.m.	71·6	88·0	16·4	" "	3 p.m.	78·4	82·4	4·0
" "	9 "	67·9	84·3	16·4	" "	9 "	71·4	75·8	4·4
" 2	9 a.m.	70·0	85·8	15·8	" 17	9 a.m.	65·0	69·2	4·2
" "	3 p.m.	72·5	87·9	15·4	" "	3 p.m.	69·0	72·9	3·9
" "	9 "	70·0	85·2	15·2	" "	9 "	66·0	70·0	4·0
" 3	9 a.m.	75·2	89·7	14·5	" 18	9 a.m.	66·0	69·4	3·4
" "	3 p.m.	74·5	88·6	14·1	" "	3 p.m.	72·2	75·7	3·5
" "	9 "	71·2	85·2	14·0	" "	9 "	66·3	69·8	3·5
" 4	9 a.m.	74·0	87·3	13·3	" 19	9 a.m.	70·0	73·1	3·1
" "	3 p.m.	74·7	87·9	13·2	" "	3 p.m.	"	"	"
" "	9 "	68·0	81·0	13·0	" "	9 "	"	"	"
" 5	9 a.m.	71·0	83·2	12·2	" 20	9 a.m.	72·8	75·6	2·8
" "	3 p.m.	"	"	"	" "	3 p.m.	73·2	76·0	3·2
" "	9 "	"	"	"	" "	9 "	68·5	71·4	2·9
" 6	9 a.m.	71·1	82·9	11·8	" 21	9 a.m.	74·2	76·7	2·5
" "	3 p.m.	75·3	86·6	11·3	" "	3 p.m.	77·6	79·6	2·0
" "	9 "	70·0	81·1	11·1	" "	9 "	70·6	73·0	2·4
" 7	9 a.m.	74·0	84·4	10·4	" 22	9 a.m.	68·0	70·0	2·2
" "	3 p.m.	75·8	85·9	10·1	" "	3 p.m.	69·4	71·2	1·8
" "	9 "	71·7	82·0	10·3	" "	9 "	67·0	69·0	2·0
" 8	9 a.m.	75·0	84·7	9·7	" 23	9 a.m.	67·7	69·0	1·3
" "	3 p.m.	76·2	85·6	9·4	" "	3 p.m.	73·1	74·8	1·7
" "	9 "	72·0	81·3	9·3	" "	9 "	70·1	71·8	1·7

READINGS—*continued.*

Date.	Time.	Standard.	Dry bulb.	Difference.	Date.	Time.	Standard.	Dry bulb.	Difference.
March 24	9 a.m.	73·0	74·5	1·5	April 9	9 a.m.	60·8	61·7	0·9
" "	3 p.m.	81·9	83·2	1·3	" "	3 p.m.	"	"	"
" "	9 "	77·8	79·3	1·5	" "	9 "	"	"	"
" 25	9 a.m.	77·8	78·9	1·1	" 10	9 a.m.	64·2	65·3	1·1
" "	3 p.m.	82·5	83·4	0·9	" "	3 p.m.	65·8	66·8	1·0
" "	9 "	81·2	82·6	1·4	" "	9 "	58·5	59·0	0·5
" 26	9 a.m.	82·3	83·1	0·8	" 11	9 a.m.	57·3	59·1	1·8
" "	3 p.m.	"	"	"	" "	3 p.m.	66·4	68·0	1·6
" "	9 "	"	"	"	" "	9 "	63·8	65·3	1·5
" 27	9 a.m.	69·4	70·1	0·7	" 12	9 a.m.	61·2	63·2	2·0
" "	3 p.m.	70·7	71·3	0·6	" "	3 p.m.	65·0	66·6	1·6
" "	9 "	67·2	68·0	0·8	" "	9 "	62·1	64·0	1·9
" 28	9 a.m.	67·7	68·8	1·1	" 13	9 a.m.	63·9	67·0	3·1
" "	3 p.m.	72·1	72·9	0·8	" "	3 p.m.	65·0	67·6	2·6
" "	9 "	68·2	69·3	1·1	" "	9 "	63·0	66·3	3·3
" 29	9 a.m.	65·7	66·6	0·9	" 14	9 a.m.	67·4	70·4	3·0
" "	3 p.m.	71·7	72·5	0·8	" "	3 p.m.	"	"	"
" "	9 "	69·3	70·3	1·0	" "	9 "	"	"	"
" 30	9 a.m.	70·0	70·8	0·8	" 15	9 a.m.	64·7	66·7	2·0
" "	3 p.m.	77·0	77·8	0·8	" "	3 p.m.	71·0	73·0	2·0
" "	9 "	63·0	63·9	0·9	" "	9 "	65·0	67·0	2·0
" 31	9 a.m.	60·8	61·2	0·4	" 16	9 a.m.	62·2	64·9	2·7
" "	3 p.m.	74·3	75·0	0·7	" "	3 p.m.	"	"	"
" "	9 "	64·8	65·6	0·8	" "	9 "	"	"	"
April 1	9 a.m.	65·2	65·7	0·5	" 17	9 a.m.	63·2	65·0	1·8
" "	3 p.m.	71·0	71·5	0·5	" "	3 p.m.	65·7	67·6	1·9
" "	9 "	63·5	64·2	0·7	" "	9 "	59·7	61·0	1·3
" 2	9 a.m.	65·2	65·8	0·6	" 18	9 a.m.	57·3	58·5	1·2
" "	3 p.m.	"	"	"	" "	3 p.m.	68·7	70·0	1·3
" "	9 "	"	"	"	" "	9 "	64·7	66·3	1·6
" 3	9 a.m.	63·8	64·2	0·4	" 19	9 a.m.	60·0	61·0	1·0
" "	3 p.m.	71·8	72·5	0·7	" "	3 p.m.	69·7	71·7	2·0
" "	9 "	66·0	67·2	1·2	" "	9 "	61·6	62·6	1·0
" 4	9 a.m.	67·0	68·0	1·0	" 20	9 a.m.	60·0	61·0	1·0
" "	3 p.m.	75·8	76·5	0·7	" "	3 p.m.	75·5	76·5	1·0
" "	9 "	70·7	71·4	0·7	" "	9 "	68·0	69·0	1·0
" 5	9 a.m.	77·0	77·8	0·8	" 21	9 a.m.	67·9	68·8	0·9
" "	3 p.m.	85·0	85·6	0·6	" "	3 p.m.	75·5	76·4	0·9
" "	9 "	71·6	72·2	0·6	" "	9 "	68·0	69·0	1·0
" 6	9 a.m.	67·5	68·0	0·5	" 22	9 a.m.	64·3	65·6	1·3
" "	3 p.m.	73·8	74·3	0·5	" "	3 p.m.	77·2	78·9	1·7
" "	9 "	66·2	67·0	0·8	" "	9 "	67·0	68·2	1·2
" 7	9 a.m.	67·6	68·5	0·9	" 23	9 a.m.	61·9	62·8	0·9
" "	3 p.m.	74·0	75·0	1·0	" "	3 p.m.	"	"	"
" "	9 "	65·2	66·2	1·0	" "	9 "	"	"	"
" 8	9 a.m.	64·8	65·2	0·4	" 24	9 a.m.	61·5	62·4	0·9
" "	3 p.m.	66·0	66·9	0·9	" "	3 p.m.	69·0	70·0	1·0
" "	9 "	56·0	56·8	0·8	" "	9 "	64·1	65·2	1·1

READINGS—*continued.*

Date.	Time.	Standard.	Dry bulb.	Difference.	Date.	Time.	Standard.	Dry bulb.	Difference.
April 25	9 a.m.	60·8	62·0	1·2	May 11	9 a.m.	60·5	67·2	6·7
” ”	3 p.m.	74·2	75·2	1·0	” ”	3 p.m.	69·0	75·7	6·7
” ”	9 ”	67·8	69·0	1·2	” ”	9 ”	66·5	73·2	6·7
” 26	9 a.m.	63·7	64·8	1·1	” 12	9 a.m.	68·0	74·5	6·5
” ”	3 p.m.	66·5	67·6	1·1	” ”	3 p.m.	73·7	79·9	6·2
” ”	9 ”	64·1	65·6	1·5	” ”	9 ”	66·0	72·0	6·0
” 27	9 a.m.	62·2	63·0	0·8	” 13	9 a.m.	59·0	64·6	5·6
” ”	3 p.m.	69·5	70·5	1·0	” ”	3 p.m.	66·8	72·7	5·9
” ”	9 ”	65·8	66·9	1·1	” ”	9 ”	59·7	65·5	5·8
” 28	9 a.m.	63·0	64·6	1·6	” 14	9 a.m.	53·0	58·5	5·5
” ”	3 p.m.	77·6	79·0	1·4	” ”	3 p.m.	”	”	”
” ”	9 ”	67·3	68·4	1·1	” ”	9 ”	”	”	”
” 29	9 a.m.	58·9	59·8	0·9	” 15	9 a.m.	53·8	59·0	5·2
” ”	3 p.m.	68·0	69·0	1·0	” ”	3 p.m.	57·6	62·8	5·2
” ”	9 ”	61·2	62·3	1·1	” ”	9 ”	55·8	60·9	5·1
” 30	9 a.m.	58·0	58·9	0·9	” 16	9 a.m.	53·2	58·5	5·3
” ”	3 p.m.	”	”	”	” ”	3 p.m.	61·2	66·0	5·2
” ”	9 ”	”	”	”	” ”	9 ”	54·7	59·4	4·7
May 1	9 a.m.	57·3	58·2	0·9	” 17	9 a.m.	53·5	58·0	4·5
” ”	3 p.m.	60·2	61·2	1·0	” ”	3 p.m.	59·0	63·5	4·5
” ”	9 ”	59·5	60·9	1·4	” ”	9 ”	56·3	61·0	5·3
” 2	9 a.m.	56·9	57·9	1·0	” 18	9 a.m.	55·6	59·8	4·2
” ”	3 p.m.	67·0	68·0	1·0	” ”	3 p.m.	61·0	65·2	4·2
” ”	9 ”	62·0	63·0	1·0	” ”	9 ”	57·2	61·2	4·0
” 3	9 a.m.	56·4	57·5	1·1	” 19	9 a.m.	55·9	59·9	4·0
” ”	3 p.m.	68·2	69·3	1·1	” ”	3 p.m.	59·2	63·0	3·8
” ”	9 ”	63·7	64·7	1·0	” ”	9 ”	58·0	62·0	4·0
” 4	9 a.m.	58·0	63·8	5·8	” 20	9 a.m.	57·0	60·9	3·9
” ”	3 p.m.	64·5	70·2	5·7	” ”	3 p.m.	59·2	63·3	4·1
” ”	9 ”	62·6	68·2	5·6	” ”	9 ”	60·1	64·0	3·9
” 5	9 a.m.	58·8	63·7	4·9	” 21	9 a.m.	59·0	63·2	4·2
” ”	3 p.m.	64·8	69·7	4·9	” ”	3 p.m.	”	”	”
” ”	9 ”	61·1	65·9	4·8	” ”	9 ”	”	”	”
” 6	9 a.m.	61·0	65·0	4·0	” 22	9 a.m.	60·4	65·0	4·6
” ”	3 p.m.	62·5	66·8	4·3	” ”	3 p.m.	64·0	68·3	4·3
” ”	9 ”	61·5	65·8	4·3	” ”	9 ”	60·6	64·8	4·2
” 7	9 a.m.	61·9	66·4	4·5	” 23	9 a.m.	58·4	62·9	4·5
” ”	3 p.m.	”	”	”	” ”	3 p.m.	66·9	71·2	4·3
” ”	9 ”	”	”	”	” ”	9 ”	57·9	61·9	4·0
” 8	9 a.m.	58·7	71·0	13·7	” 24	9 a.m.	56·3	60·0	3·7
” ”	3 p.m.	63·6	72·9	9·3	” ”	3 p.m.	64·7	68·3	3·6
” ”	9 ”	58·7	67·7	9·0	” ”	9 ”	59·2	62·5	3·3
” 9	9 a.m.	57·2	65·8	8·6	” 25	9 a.m.	53·6	56·8	3·2
” ”	3 p.m.	68·0	76·4	8·4	” ”	3 p.m.	64·0	67·3	3·3
” ”	9 ”	60·2	68·3	8·1	” ”	9 ”	56·5	59·4	2·9
” 10	9 a.m.	56·5	64·0	7·5	” 26	9 a.m.	53·5	56·4	2·9
” ”	3 p.m.	67·9	70·2	2·3	” ”	3 p.m.	62·2	65·0	2·8
” ”	9 ”	63·0	70·4	7·4	” ”	9 ”	61·4	64·0	2·6

Readings—*continued.*

Date.		Time.	Standard.	Dry bulb.	Difference.	Date.		Time.	Standard.	Dry bulb.	Difference.
May	27	9 a.m.	60·2	62·7	2·5	June	4	9 a.m.	48·0	49·0	1·0
„	„	3 p.m.	60·1	62·3	2·2	„	„	3 p.m.	„	„	„
„	„	9 „	62·3	64·8	2·5	„	„	9 „	„	„	„
„	28	9 a.m.	62·2	64·4	2·2	„	5	9 a.m.	48·8	49·9	1·1
„	„	3 p.m.	„	„	„	„	„	3 p.m.	60·0	61·3	1·3
„	„	9 „	„	„	„	„	„	9 „	54·7	56·0	1·3
„	29	9 a.m.	56·6	58·4	1·8	„	6	9 a.m.	51·3	52·5	1·2
„	„	3 p.m.	62·0	64·0	2·0	„	„	3 p.m.	53·9	55·3	1·4
„	„	9 „	63·1	65·2	2·1	„	„	9 „			
„	30	9 a.m.	61·5	63·5	2·0	„	7	9 a.m.			
„	„	3 p.m.	61·0	62·6	1·6	„	„	3 p.m.			
„	„	9 „	60·4	62·3	1·9	„	„	9 „			
„	31	9 a.m.	54·7	56·2	1·5	„	8	9 a.m.			
„	„	3 p.m.	59·1	60·7	1·6	„	„	3 p.m.			
„	„	9 „	52·8	54·4	1·6	„	„	9 „			
June	1	9 a.m.	53·0	54·5	1·5	„	9	9 a.m.			
„	„	3 p.m.	60·4	62·0	1·6	„	„	3 p.m.			
„	„	9 „	54·8	56·2	1·4	„	„	9 „			
„	2	9 a.m.	56·0	57·4	1·4	„	10	9 a.m.			
„	„	3 p.m.	63·0	64·4	1·4	„	„	3 p.m.			
„	„	9 „	53·2	54·6	1·4	„	„	9 „			
„	3	9 a.m.	48·9	50·0	1·1	„	11	9 a.m.			
„	„	3 p.m.	58·3	59·9	1·6	„	„	3 p.m.			
„	„	9 „	50·4	51·7	1·3	„	„	9 „			

B.

Readings of Standard and Dry Bulb Thermometers, Sydney Observatory, 1872.

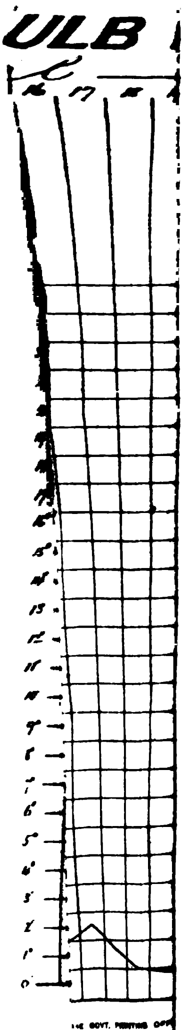
Date.	Time.	Standard.	Dry Bulb.	Difference.
April 18	9 a.m.	62·5	62·6	0·1
„ „	3 p.m.	67·0	67·1	0·1
„ „	9 „	62·4	62·7	0·3
„ 19	9 a.m.	60·1	60·3	0·2
„ „	3 p.m.	66·1	67·2	1·1
„ „	9 „	61·1	62·0	0·9
„ 20	9 a.m.	58·7	59·5	0·8
„ „	3 p.m.	66·5	67·2	0·7
„ „	9 „	62·6	63·0	0·4
„ 21	9 a.m.	63·5	64·2	0·7
„ „	3 p.m.	„	„	„
„ „	9 „	„	„	„
„ 22	9 a.m.	55·1	55·5	0·4
„ „	3 p.m.	64·0	64·0	0·0
„ „	9 „	55·0	55·1	0·1

C.

Readings of Minimum Thermometers on the grass corrected index errors.*

Date.	1	Difference 1—2.	2	3	Differen 3—2.
May 26	42·0	0·3	42·3	46·9	4·9
„ 27	55·7	3·2	52·5	53·3	0·8
„ 28	54·5	3·5	51·0	55·2	4·2
„ 29	51·0	3·3	47·7	51·9	4·2
„ 30	52·0	3·1	48·9	53·2	4·3
„ 31	46·5	3·4	43·1	47·6	4·5
June 1	37·5	3·4	34·1	38·7	4·6
„ 2	39·5	2·9	36·6	40·7	4·1
„ 3	37·3	3·5	33·8	38·7	4·9
„ 4	37·5	3·2	34·3	38·8	4·5
„ 5	39·9	3·4	36·5	41·3	4·8
„ 6	44·5	2·6	41·9	46·3	4·4
„ 7	45·0	3·9	41·1	45·4	4·3
Means	44·8	3·0	41·8	46·0	4·2

* Index errors in each case determined by comparison with the standard *in air*.
No. 1—Glass Thermometer on wooden stand.
No. 2—Glass Thermometer on zinc stand.
No. 3— Do. do.



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ON THE ORIGIN AND MIGRATIONS OF THE POLYNESIAN NATION;

DEMONSTRATING THEIR ORIGINAL DISCOVERY AND PROGRESSIVE SETTLEMENT OF THE CONTINENT OF AMERICA.

By the Rev. Dr. Lang.

[*Read before the Royal Society of N.S.W.*, 5 *July*, 1876.]

In the outset of a series of lectures delivered before this Society seven or eight years since, I observed that the singular phenomenon which the South Sea Islands present to the eye of a philosophical observer is perhaps one of the most difficult to account for that has ever engaged the efforts or the ingenuity of man. From the Sandwich Islands in the Northern, to New Zealand in the Southern, Hemisphere; from the Indian Archipelago to Easter Island, adjoining the continent of America—an extent of ocean comprising sixty degrees of latitude and a hundred and twenty of longitude, that is exactly twice the extent of the Roman Empire in its greatest glory—the same primitive language is spoken, the same singular customs prevail, the same semi-barbarous nation inhabits the multitude of the isles.

In using this language, however, I would not be understood to include the numerous islands and groups of islands of the Western Pacific; the inhabitants of which are all remarkably different from the other South Sea Islanders, and would seem to be derived from the same primitive stock as the aborigines of Australia and the Papuans of New Guinea. These islanders of the Western Pacific are all of a much darker hue than those of Polynesia Proper, or the Eastern Islanders, many of them being jet black; and there is this remarkable distinction between the two races, that while the languages of Eastern Polynesia are all mere dialects of the same primitive tongue, there is an infinity of languages in the islands of Western Polynesia, and all remarkably different from each other, every island of any size having one of its own, and the larger islands three or four.

My attention was strongly directed to this very interesting subject at an early period after my arrival in this Colony for the first time in the year 1823; and as there was a more frequent intercourse at that period than in later years, between New South

Wales and certain groups of islands in the Pacific, I employed myself as I could from time to time in investigating the manners and customs of the islanders generally and the modes and causes of their migrations from island to island, and in endeavouring, if possible, to ascertain from what part of the surrounding world they originally came.

The Polynesians, like all other islanders, are a maritime people, very frequently if not constantly at sea, and ever and anon making short voyages from island to island in their respective groups. Now although the trade winds in the Pacific are remarkably regular, they are not so uniformly. Sudden and violent westerly gales arise from time to time, and when these are contrary to the course of the unfortunate islander, passing perhaps from one well-known island to another, he may be driven out to sea, notwithstanding all his efforts to the contrary, and may never regain his native isle. In such cases, unless he happens to be cast on some previously unknown island, he will at length be engulphed in the waves. This then is the first of the ways in which the numberless islands of the Pacific Ocean have been successively peopled, in the course of ages past, at a cost of human life and suffering absolutely appalling to think of. The second of the modes in which the numberless groups of the Pacific Ocean have been successively peopled in past ages is from the event of war. In all past time the islands of the Pacific have been the scene of almost perpetual and savage warfare; and it has often happened that the vanquished party have been obliged to trust themselves in their canoes to the mercy of the winds and waves, and the chance of being cast upon some unknown island, rather than remain in their native island to be butchered wholesale by their victors. This has in all likelihood been the origin of cannibalism in the South Sea Islands, the wretched survivors in these uncertain and perilous voyages being compelled from sheer necessity to kill and prey upon one another ere they could reach, if they ever did, any land. The state of things I have thus pourtrayed accounts for another and remarkable fact in Polynesian history, viz., the absence of any distinction of caste among the natives of the New Zealand group of islands, while in the Tonga or Friendly Islands, which the vicinity and the resemblance of language in these groups would indicate as the original home of the New Zealand race, there is a full development of caste. For in whatever manner the original forefathers of New Zealand had left Tonga, their supposed native isle, all of the lower castes would be mercilessly butchered one by one for the subsistence of the rest, and the whole of the original inhabitants of their new found land would thus be Rangatiras or gentlemen. The spirit of adventure, which in many cases has been remarkably developed among the South Sea Islanders, must also have tended strongly to the spread of mankind over the number-

less isles of the Pacific. At all events, since the islands of the Pacific were first known to civilized men, there have been numerous instances of all these modes—by accident, by the event of war, and by the spirit of adventure—of carrying population to the most distant islands. The captain of the vessel in which I made my first voyage from Sydney to England, in the year 1824, having previously been the master of a whaler in the Pacific, told me that on one occasion he happened to fall in with a canoe with a number of natives on board who had accidentally been driven to sea by a sudden gale, and having nearly expended all their provisions, were utterly unable to find their way back to their native isle. The benevolent shipmaster took them all on board his vessel and supplied them with the necessary food for their subsistence. But as it would have taken him about three hundred miles out of his proper course to carry them to their native island, he merely gave them a compass, and showing them how to use it he left them to pursue their homeward voyage themselves. In due time the summits of the mountains of Tahiti, their native isle, hove in sight, and the natives leaped and danced for joy at sight of them in their canoe. Then looking first at the land and then at the compass, their mysterious guide, which they supposed alive, they exclaimed, "The cunning little thing—it saw it all the time!"

The next question before us is from what portion of the habitable globe has the Polynesian race been derived, and with what other family or tribe of the earth's inhabitants does it exhibit any affinity?

Before attempting to answer this question, I would observe that there are certain writers who maintain that the Polynesians could not possibly have come from the westward or the continent of Asia, from the prevalence of the easterly or trade winds of both hemispheres. De Zuniga, a Spanish writer of some celebrity, and the author of a history of the Philippine Islands, in which he held office under the Spanish Government, maintains that the Polynesians could never have made their way across the Pacific from the westward, in consequence of the uniform prevalence of the easterly trade winds in that ocean. He therefore advances the singular hypothesis that the South Sea Islands were originally peopled from America, and alleges in proof of it the remarkable resemblance of the language of the American Indians of Chili, of which certain specimens were contained in the history of that country by the Spanish historian Erçilla, to that of Tagala in the Philippine Islands; forgetting that the natives of continents are never maritime people like those of islands, and not taking into consideration the obvious fact that even if the American Indians had been disposed to maritime adventure, they might have made thousands of voyages from the west coast of America ere ever they could hit upon any one of the Islands of the Pacific, the nearest of

which is at least 2,000 miles from the American land. But this testimony of that eminent navigator La Perouse is decisive against the hypothesis of De Zuniga. "Westerly winds," says that distinguished navigator, "are at least as prevalent as those from the eastward in the vicinity of the equator, in a zone of 7 or 8 degrees north and south; and they" (that is the winds in the equatorial regions) "are so variable that it is very little more difficult to make a voyage to the eastward than to the westward." To the same effect Captain (afterwards Admiral) Hunter, R.N., the second Governor of New South Wales, observes in the narrative of his voyage from Port Jackson to Batavia, in the year 1791, "It was very clear to me, from the winds we had experienced since we came to the northward of the line, that at this time of the year (the end of July), and generally during the height of the north-west monsoon in the China seas, these (westerly) winds do sometimes extend far to the eastward of the Philippine Islands, and frequently blow in very heavy gales."

Having thus disposed of the preliminary objection as to the alleged impossibility of getting to the eastward in the Pacific Ocean, I observe that the Polynesian race exhibits the clearest evidence of an Asiatic origin.

First,—In the distinction of caste, which, as I have already observed, although not existing in New Zealand, for the reason I have mentioned, was as clearly developed in the Friendly Islands as it ever was in India.

Secondly,—In the singular institution of Taboo, which obtains universally in the South Sea Islands, and is evidently also of Asiatic origin. The word *Taboo* corresponds pretty nearly with the Latin *sacer* or the Greek *αναθεμα*, the person, place, or thing under *taboo*, being what the Latins would call *sacer diis cœlestibus*, holy or sacred to the celestial gods, or *sacer diis infernis*, accursed or devoted to the infernal gods. It may be difficult indeed to account for so singular an institution as the Polynesian taboo; but its Asiatic origin is evident and unquestionable. Its influence and operation may be traced from the Straits of Malacca, across the whole Continent of Asia, to the Sea of Tiberias and the Isles of Greece. In Ionia, in Hindostan, and in Tahiti, the person, the place, or the thing that was subjected to the influence of the mysterious *taboo* was, in the words of the Latin historian, *auguriis patrum, et prisca formidine sacrum*, abstracted from the common usages of life, by a superstitious dread, the result of ancient religious observances.

Thirdly,—Numerous Asiatic customs and observances are practised in the South Sea Islands, as well as in the Indian Archipelago, which closely adjoins the Continent of Asia, and must therefore have been originally peopled from that continent. Of these, however, our time will only allow me to mention one,

but a very remarkable one—I mean the filthy practice of chewing the areca nut or *piper betel*, so prevalent in the East Indies—a practice which makes the mouth unnaturally red and the teeth black. This Asiatic practice was observed by Captain Hunter among the natives of the Duke of York's Island to the eastward of New Ireland; and by Captain Hovell, of the "Young Australian," among the inhabitants of Banks' Island, still further east, or in 170° west longitude.

Fourthly,—The evidence of language in regard to the origin of the South Sea Islands is still stronger and less open to objection. "Language," says the celebrated Horne Tooke, "cannot lie, and from the language of every nation we may with certainty collect its origin."

"One original language," observes Sir Stamford Raffles, "seems in a very remote period to have pervaded the whole Indian Archipelago, and to have spread (perhaps with the population) towards Madagascar on one side and the islands in the South Seas on the other." And in confirmation of this idea, Mr. Marsden, the author of a history of Sumatra, and an eminent authority in all matters connected with the Indian Archipelago, informs us that "upon analysing a list of thirty-five Malayan words, of the simplest and most genuine character, twenty will be found to correspond with the Polynesian generally, seven with a small portion of the dialects of the South Seas, and seven, as far as our present knowledge extends with the Malayan itself."

There is another very remarkable fact, under the head of language, which I shall merely mention for the present, as I shall have to refer to it more particularly in the sequel, and which proves incontestibly the original identity of the Polynesian race with the Indo-Chinese nations of South-eastern Asia and the inhabitants of the Indian Archipelago; for in common with these nations the Polynesians, in the islands in which their social system was more fully developed, as in the Tonga or Friendly Islands, as compared with New Zealand, there was a language of ceremony or deference distinct altogether from the language of common life. My idea therefore is, that the forefathers of the Polynesian race were somehow struck off from the other or Malayan tribes of the Indian Archipelago at so early a period in the history of mankind as within five hundred years after the deluge, according to the Hebrew chronology, and that in the course of many successive generations, and under the influence of those occasional westerly gales that prevail in the Pacific, they had crossed that ocean to the eastward, within the Equatorial belt of La Perouse if not rather considerably to the northward, according to our very able Member, Mr. Edward Hill, from their supposed starting point in the Philippine Islands, to Pasquas or Easter Island, in latitude 27° in the Southern Pacific, within

2,000 miles of the American land. There, at all events, our own great navigator, Captain Cook, actually found not only a people of the real Polynesian type but the colossal remains of their long extinct civilization.

And this extreme antiquity which I assign to the Polynesian race is not merely a matter of conjecture. There are two remarkable notes of time in the case that throw us back irresistibly to the very *cunabula gentis*, the actual cradle of the Polynesian race. The distinguished scholars of the Indian Archipelago—Sir Thomas Raffles, Dr. Leyden, Mr. Crawford, Mr. Marsden, and others—inform us that there have been two distinct foreign infusions into the ancient Malayan tongue, viz., an Arabic infusion co-eval with the era of Mahomet and the Mahometan invasion of the East. Now, of this copious Arabic infusion in the Malayan language, which may be dated as high as the seventh century of our era, there is no trace in the Polynesian tongue—a circumstance which proves incontestibly that the Polynesian race had been struck off from the Malayan tribes of the Indian Archipelago before the era of Mahomet. But there is another and much more ancient foreign infusion in the Malayan language, of which also there is no trace in the Polynesian dialect, I mean the Sanscrit infusion. This, therefore, throws back into the very highest antiquity the origin of the Polynesian race as a distinct family of mankind.

To retrace our steps for a moment, we have now established the important fact, that under the influence of causes that are still in operation throughout the South Sea Islands, the Polynesian race has spread itself in the course of long ages past over the whole extent of the Pacific Ocean—from the Sandwich Islands in the northern to New Zealand in the southern hemisphere, and from the western shores of the Pacific, to Easter Island, within 1,800 or at the utmost 2,000 miles of the American land.

At the time when I was earnestly pursuing my investigations into the origin and migrations of the Polynesian race, I was myself crossing the Pacific, on my second voyage from Sydney to London, in the year 1830, having carried with me to sea for the express purpose, such works bearing on the subject as I could then procure in the Colony. We had encountered on that occasion a strong southerly gale of seven days continuance after rounding the North Cape of New Zealand; and for part of that time we had the mountains of that island clearly in sight. We then got a strong westerly gale that carried us the whole way right across the Pacific to Cape Horn, with close-reefed topsails, at the rate of ten or eleven knots an hour. In these circumstances, when reading De Zuniga's work, in which he tells us that the aboriginal languages of Tagala, in the Philippines, and of Araucania, in Chili, were remarkably similar

(*bastante conformes*), and alleges the fact as a reason for his strange hypothesis, that the South Sea Islands were peopled from America; it struck me all at once and with prodigious force, when glancing, as I could not help doing at the moment, at the possible results to which the suggestion might lead, that the converse of the Spaniard's hypothesis might perhaps be the true idea in the case, and that instead of Easter Island having been colonized and settled from America, some unfortunate canoe suddenly blown off from that island by some such violent westerly gale as the one before which we were then careering over the great waters of the Pacific, might have landed the first cargo of human beings on the continent of America.

It would seem indeed as if Easter Island had been placed in its actual position by the all wise and beneficent Creator for the express purpose which in all likelihood no other island in the Pacific could have served—of ensuring the discovery and settlement of that great continent by the Polynesian race—of proving, so to speak, a stepping stone between Polynesia and America. Situated, as that island is, in 27 degrees south latitude, that is, well up in the south temperate zone, and very nearly in the latitude of the city of Brisbane, on this coast, it is equally beyond the influence of the south-easterly trade winds of the intertropical regions, and within the full sweep of the strong westerly gales of the southern Pacific. Such gales as the one I experienced in the year 1830—and I have experienced various others of the same kind in subsequent voyages across the Pacific—such a gale as I have referred to would certainly extend as far north as Easter Island; and, once caught within its resistless sweep, the hapless Polynesian craft would be driven before it, in all likelihood in less than ten days, to the American land. And where is it supposable that a Polynesian vessel would in such circumstances reach the American continent? Why, the westerly gale I have supposed would admit of no deviation from a due easterly course, either northward or southward, in the case of any hapless vessel accidentally brought within its power. Such a vessel would therefore reach the unknown land to the eastward, as nearly as possible in the latitude of Easter Island—that is, somewhere near the present seaport town of Copiapo, in the Republic of Chili. That, I am confident, was the place where the American continent was first trodden by the foot of man.

I am happy to be able to state in this stage of our inquiry that an able and scientific member of this Society, Mr. Edward Hill—who is eminently qualified for offering a reliable opinion on the subject of our present investigations, from having himself spent not less than four years in traversing the Pacific Ocean in all directions, and especially from having made the origin and migrations of the Polynesian nation his particular study for

many years past—has assured me that he coincides entirely with me in the views I have stated both in regard to the origin of the Polynesian nation in the Indian Archipelago and to the courses which the individuals of that nation must have taken in crossing the Pacific in the regions of its greatest breadth from their starting point in the Philippine Islands to Pasquas or Easter Island, which he reckons is situated 2,200 miles from the American land. There he leaves me, however, not from any doubt as to my being then on the right track for ascertaining how both North and South America were originally peopled, but because he had never entertained the thought of following the Polynesians across the intervening tract of ocean that separates Easter Island from the mainland of America.

Taking it for granted, therefore, for the sake of argument, that that continent was originally reached by a canoe full of Polynesians, who had been accidentally blown off the land from Easter Island by one of those sudden, violent, and protracted westerly gales that prevail at certain seasons in the southern Pacific, and had crossed the intervening breadth of ocean to the American land, somewhere near Copiapo, in the Republic of Chili, what would be the result of these unfortunates finding themselves in their new-found-land? Why, like all emigrants from the old world to some colonial field beyond seas, they would just reproduce in their new settlement the whole framework of society on the model on which it was constructed in their native isle. They would practice the same manners and customs as had obtained in their fatherland, and they would construct both their private habitations and their public buildings on the same plan or model to which they had been accustomed in the land of their nativity.

Now, this is precisely what we find to have been the result of the supposed original discovery of America by a handful of famished Polynesians at a very early period in the history of mankind. We find the whole framework of society among the aborigines of America constructed on precisely the same model as in Polynesia; we find the same singular manners and customs prevalent in both cases; and we find those wonderful remains of an extinct civilization in America that excite the astonishment of modern civilization, of precisely the same character and aspect as if they had been erected by a Polynesian architect.

Reserving the proof of this for the present, I would now present the Society with a brief statement of the theories put forth by a great variety of authorities in regard to the origin of the Indians of America, in the recent work of an eminent American historian, Mr. Bancroft, entitled "The Native Races of the Pacific States of North America." Before doing so, however, I would lay down as a test for judging and deciding on all

such theories the principle established by the great philosopher and traveller, Humboldt, and confirmed and strengthened by other two very eminent authorities on this subject—Dr. Morton, of Philadelphia, and Dr. Von Martius, of Bavaria.

What then is the testimony of that eminent philosopher and keen observer, Baron Humboldt, on the subject of the aborigines of America? Why, it is as follows:—"The nations of America, except those which border on the Polar circle, *form a single race*, characterised by the form of the skull, the colour of the skin, the extreme thinness of the beard, and straight, glossy hair."*

And again, "I think I discover, in the mythology of the Americans, in the style of their paintings, in their languages, and especially in their external conformation, the descendants of a race of men, which, early separated from the rest of mankind, has followed for a lengthened series of ages a peculiar road in the unfolding of its intellectual faculties, and in its tendency towards civilization."†

Dr. Morton, of Philadelphia, with whom I spent an evening in his own house in that city, in the year 1840, was the author of a scientific work of the highest character,‡ entitled "Crania Americana," containing accurate drawings of the *crania* of all the aboriginal races of that continent, from the Esquimaux region in the far north to Cape Horn. Having heard very shortly before of a Professor in the German University of Freiburg maintaining very dogmatically that the Azteck conquerors and the comparatively civilized builders of the pyramids and the other wonderful ruins in America were a totally different race from the wild Indians of the forest of the present day, Dr. Morton assured me that there was no difference in the skulls of the aborigines, that they were all one people, the descendants of one common stock, one nation, and on asking him to what section of the human family the Indo-Americans bore the greatest resemblance in their craniological development, he replied at once—the Polynesian.

I shall be reminded, however, that the Indo-American nations of Peru and Mexico were in a comparatively high state of civilization at the period of the Spanish conquest. When America was first discovered and colonized by Europeans, the western equatorial regions of that continent were the seat of extensive, flourishing, and powerful empires, the inhabitants of which were well acquainted with the science of government, and had made no inconsiderable progress in the arts of civilization. At the time when the institution of posts was unknown in Europe it

* Humboldt's Researches, vol. i, p. 15.

† *Ibid.*, p. 200.

‡ Dr. Morton had quoted in his great work a work of mine published in London in 1834, on the subject of this paper.

was in full operation in the Empire of Mexico; at a time when a public highway was either a relic of Roman greatness or a sort of nonentity in England, there were roads of 1,500 miles in length in the Empire of Peru. The feudal system was as firmly established in these transatlantic kingdoms as in France, and the system of etiquette that regulated the intercourse of the different ranks of society, was as complete and as much respected as in the Court of Philip the Second. The Peruvians were ignorant of the art of forming an arch, but they had constructed suspension bridges across frightful ravines; they had no implements of iron; but their forefathers could move blocks of stone as huge as the Sphinxes and the Memnons of Egypt. The Mexicans were unacquainted with the art of forming cast metal pipes, but they had constructed dykes or causeways as compact as those of Holland; and their capital, which was situated in the centre of a salt water lake, was supplied with a copious stream of fresh water, brought from beyond the lake in an aqueduct of baked clay. They had had no Cadmus to give them an alphabet, but their picture writing enabled them to preserve the memory of past events and to transmit it to posterity.

"The Indigenous race of the New World," observes Dr. Von Martius, an eminent Bavarian philosopher, who travelled in the Brazils during the earlier portion of the present century, "is distinguished from all the other nations of the earth, externally by peculiarities of make, but still more internally by their state of mind and intellect. The aboriginal American is at once in the incapacity of infancy and unpliancy of old age; he unites the opposite poles of intellectual life." And again, "The first germs of development of the human race in America can be sought nowhere except in that quarter of the globe.* In short, Humboldt, Dr. Morton, of Philadelphia, and Dr. Von Martius, all give it as their deliberate opinion that the aborigines of America are all, with the exception of the Esquimaux of the Polar circle, one people, and unlike every other people on the face of the earth. But while both Humboldt and Dr. Morton modestly decline pronouncing any judgment as to their origin, Dr. Von Martius, in the true spirit of modern scepticism, tells us at once that they had sprung into existence on the spot.

To return now to Mr. Bancroft, although that writer lays down no theory of his own as to the original peopling of America, he evidently inclines to the opinion of those who derive the Indo-Americans from Eastern Asia by Behring's Straits. "The theory that America was peopled," says Mr. Bancroft, "or at least, partly peopled, from Eastern Asia, is certainly more widely advocated than any other, and in my opinion is moreover

* Von dem Rechtzustande unter der Ureinwohnern Braziliens. A paper by Dr. Von Martius, in the Royal Geographical Society's Journal, vol. ii.

based upon a more reasonable and logical foundation than any other."* But in so far as the emigration from Eastern Asia is supposed to have taken place by Behring's Straits or the Alieutian Islands, the objection taken to such a theory by the Quarterly Review (vol. xxi., pp. 334–5), is unanswerable: "We can hardly suppose that any of the pastoral hordes of Tartars would emigrate across the strait of Behring or the Alieutian Islands without carrying with them a supply of those cattle on which their whole subsistence depended." To suppose indeed that a people like the Tartars of North-eastern Asia, who live, so to speak, on horseback, and subsist almost entirely on the flesh and milk of their flocks and herds, would cross that narrow strait, either by water or on the ice when frozen, without carrying with them a single horse, a single sheep, or a single head of cattle, is quite incredible. And to talk of an extensive emigration of the Tartar nations of North-eastern Asia flying to America from before the warlike hosts of Zenghis Khan, how could a non-maritime people have crossed the intervening tract of ocean between Asia and America? or if they did, how did they come to leave all their sheep, cattle, and horses behind? But if America was first peopled, as I have supposed, by a handful of famished Polynesians, who had been suddenly driven to sea from Easter Island, and carried across the intervening ocean to America, somewhere near Copiapo in the State of Chili, in South America, the entire absence of all our domestic animals at the era of the Spanish conquest was the necessary consequence of the manner in which they had originally reached their new-found-land.

"Analogies," says Mr. Bancroft, "have been found, or thought to exist between the languages of several of the American tribes and that of the Chinese; but it is to Mexico, Central America, and Peru, and not to the north-western coast, where we should naturally expect to find them most evident."† Besides, in the important item of architecture, in which we should have expected some proofs of identity between the Chinese and the Polynesians, if there had been any original affinity between these nations, there is none whatever. Speaking of the ruins of Central America, Stephens says: "If their (the Chinese) ancient architecture is the same with their modern, it bears no resemblance whatever to these unknown ruins." Central America, vol. ii. p. 438.

It would be a mere waste of time to take into serious consideration the claims which Mr. Bancroft shows us have been put forth by various writers to the discovery and settlement of America on behalf of the Egyptians, the Phœnicians or Tyrians, and the Carthaginians. It would be inexcusable, however, to omit all men-

* The native races of the Pacific States of North America, vol. i, p. 30.
† Bancroft. *Ibid.*

tion of those that have been preferred for the Jews in general or the Ten Lost Tribes in particular. There are four principal writers on this subject, viz., Garcia, a Spaniard; Lord Kingsborough, an enthusiastic Englishman; and a Dr. Boudinot, an American divine, of Huguenot descent; but none of these writers give us any rational idea as to how the Jews could ever have crossed the Pacific, or any proof of the identity of the Indo-Americans with the Jewish people, while the far-fetched and strained analogies on which they base their theory are evidently the mere offspring of a warm imagination. If my theory as to the origin of the Polynesian nation is well founded (as I am confident it is), that nation must in all likelihood have taken its departure from the Indian Archipelago as early as the age of Abraham himself, and long before the Jews became a nation at all, and in this opinion I am not singular.

"Much," says Mr. Bancroft, "has been written to prove that the north-western parts of America were discovered and peopled by Scandinavians long before the time of Columbus. Although a great part of the evidence upon which this belief rests is unsatisfactory, and mixed up with much that is vague and undoubtedly fabulous, yet it seems to be not entirely destitute of historical proof."

Again, "We come now," says Mr. Bancroft, "to the theory that the Americans, or at least part of them, are of Celtic origin," and then he gives us the legend of Madoc, a prince of Wales, having crossed over to America, as also the opinion of Lord Monboddo that America was colonized and settled by Scotch Highlanders who had left their language in the country in proof of it.

Mr. Bancroft then alludes to the story of Atlantis, "as old as Plato," that is, of a submerged lost land that once lay "to the west of Europe," by which it has been alleged emigrants from the old world had originally crossed over by dry land to America. But there are two things fatal to all these theories. 1st. That there is no reliable evidence whatever of either a Scandinavian, or a Welsh, or of any other emigration westward from the old world to America. The emigrants of all these countries died and left no sign, no progeny. But even if there had been any considerable emigration from Europe to America, the three eminent authorities I have quoted—Humboldt, Dr. Morton, and Dr. Von Martius—assure us that the Indo-Americans could never have descended from any people of the old world, there being no other nation upon earth with which they have the slightest affinity.

"Hence it is," says Mr. Bancroft, "many not unreasonably assume that the Americans are autochthones (or created on the spot) until there is some good ground given for believing them to be of exotic origin."* Now this is the very desideratum I

* *Ibid*, 131.

propose to supply, by giving the best possible grounds for believing that the Indo-Americans are not *autochthones* or indigenous, but are intimately related, in the way of natural descent, to one of the most ancient sections of the family of man. I shall reserve the proof of this, however, for another paper.

Part II.

The points I have established in the previous part of my paper are:—

1. That the Polynesian nation, scattered as it is over the numberless islands of the vast Pacific Ocean, is of Asiatic origin and of Malayan race, and was separated from the rest of mankind at a period of the earliest antiquity in the history of man.

2. That under the operation of causes that are still in active operation in the Pacific Ocean, the forefathers of the Polynesian nation proceeded to the eastward from their original point of departure in the Indian Archipelago, and that their descendants in many successive ages and generations crossed the Pacific Ocean—discovering and occupying the numerous islands and groups of islands in their course, as well as others at great distances both north and south, till they reached their farthest east in Pasquas or Easter Island, within 2,000 miles of the American land.

3. That the same causes that had operated in carrying them to the eastward as far as Easter Island—a distance of not less than 7,000 or 8,000 miles—must have operated in carrying them still farther east, across the remaining tract of ocean from that island to somewhere near Copiapo, in the same latitude, in the Republic of Chili, in South America, where our own great navigator, Captain Cook, found them a hundred years since. And my theory is—

4. That from that landing-place they gradually proceeded northwards and eastwards during the numberless ages that have since elapsed; occupying and forming settlements in all eligible localities in their course, first in the southern and afterwards in the northern continent of America, as far as the Lakes of Canada and the coast of Labrador.

With this view I shall show you in the first place that the civilization of the more civilized Indo-American nations was exclusively Polynesian, and cast entirely in a Polynesian mould

I shall then show that the phenomena of language in America point directly to a Polynesian origin; and I shall conclude by showing that the same singular manners and customs prevail among the wild and uncivilized tribes of both nations.

I. The peculiar type of the civilization of the Indo-American nations is exhibited in some measure at least in the very remarkable architectural remains that are scattered in great profusion over both the American continents. These consist of pyramidal erections, of temples, of tumuli, and of fortifications. I have already observed that the pyramidal and colossal style of the architecture of the earlier postdiluvian nations was in all likelihood a relic of the civilization of the antediluvian world. There can be no doubt, however, of its universal prevalence in that early period of the history of our race; and wherever we can trace its existence we may rest assured that the civilization of which it is the sign was derived from the ages immediately succeeding the deluge. Now there is nothing more remarkable than the prevalence of this peculiar type of civilization, this pyramidal and colossal style of architecture, in the ruined cities of America. Humboldt, as I have already shown, compares those of Mexico with the pyramids of Egypt; and in all the recently-discovered ruins of Indo-American cities in Guatimala and Yucatan—in Copan, in Quirigua, in Palenque, and in Uxmal—pyramidal buildings are uniformly found, sometimes in great numbers, together with monolith statues, in some instances upwards of 20 feet high. "The pyramid of Papantla," says Humboldt, "is built entirely with hewn stones of an extraordinary size, and very beautifully and regularly shaped; three staircases lead to the top."* Stephens also, in his "Incidents of Travel in Central America," thus describes a ruin he had seen in the ancient Indo-American city of Copan in Guatimala: "This temple is an oblong enclosure. The front or river wall extends on a right line north and south 624 feet, and is from 60 to 90 feet in height. It is made of cut stones, from 3 to 6 feet in length, and a foot and a half in breadth. * * * The other three sides consist of ranges of steps and pyramidal structures, rising from 30 to 140 feet in height on the slope."† Now each of these remarkable buildings, to which there is nothing at all similar either in ancient or modern Europe, or even in Asia, consists of a pyramid with steps up to its top on three of its sides, while the fourth forms the wall for a temple enclosure. But the structure described, on the authority of Mr. Ellis—the temple and pyramid of Atehuru in Tahiti—is precisely of the same character, and might have been erected by the same architect from the same plan; while in Easter Island, the supposed point of departure from Polynesia to

* Humboldt's Researches, i., 89.

† Stephens' Incidents of Travel in Central America, page 87.

America, there are monolith statues quite as large as those of Copan or Quirigua. Can we doubt then that the Polynesians and Indo-Americans are the same people, and that their forefathers carried with them across the vast Pacific and to both of the American continents, the peculiar type of civilization, photographed as it had been upon their minds, that characterised the ages immediately after the deluge?

There were, properly speaking, no such buildings as temples either in Polynesia or Indo-America—what we should call their temples being merely square or rather oblong spaces, enclosed with massive walls, but without roofs. It is observed by Mitford, in his History of Greece, that the antiquity of the writings of Homer may be inferred from his silence on the subject of temples and image-worship. They were both, it would seem, equally unknown to the ancient South Sea Islanders and Indo-Americans; although in later times, and in particular localities, idolatry obtained a footing and became prevalent among them. "The Indians of the forest," says Humboldt, "when they visit occasionally the missions, conceive with difficulty the idea of a temple or an image. 'These good people,' said the missionary, 'like only processions in the open air. When I last celebrated the patron festival of my village, that of San Antonio, the Indians of Inirida were present at mass. 'Your God,' said they to me, 'keeps himself shut up in a house as if he were old and infirm; ours is in the forest, in the fields, and on the mountains of Sipapu, whence the rains come.' "* The same magnificent idea of a great Spirit pervading the world is, as is well known, prevalent among the wild Indians of North America, who have neither temples nor images—a fact that would seem to indicate that the forefathers of their race in the Indian Archipelago had been separated from the rest of mankind, before the monstrous idolatries of the East had been devised, and when the purer theology of the age immediately succeeding the deluge still prevailed among men.

There is another indication of the hoary antiquity, as well as of the identity, of the Polynesian and Indo-American races in the want of mortar or cement of any kind in their more ancient buildings. This, it seems, was one of the characteristics of that pyramidal and colossal style of architecture that obtained in the ages immediately succeeding the deluge. The Rev. Dr. Porter, for some time a missionary in the East, and now a professor in the General Assembly's College in Belfast, Ireland, who, when stationed in Syria and Damascus, had visited and described the colossal remains of the giant cities of Bashan, to which he assigns an antiquity of not less than four thousand years, thus describes

* Humboldt's Narrative, vol. v., page 273.

one of the houses which he entered in one of these cities. "The house seemed to have undergone little change from the time its old master had left it; and yet the thick nitrous crust on the floor showed that it had been deserted for long ages. The walls were perfect, nearly 5 feet thick, built of large blocks of hewn stones, *without lime or cement of any kind.* The roof was formed of large slabs of the same black basalt, lying as regularly, and jointed as closely, as if the workmen had only just completed them. They measured 12 feet in length, 18 inches in breadth, and 6 inches in thickness."* Precisely similar is the account which the American, Herman Melville, gives of the colossal remains in the Marquesas Islands. "A series of vast terraces of stone rises step by step for a considerable distance up the hill side. These terraces cannot be less than 100 yards in length and 20 in width. Their magnitude, however, is less striking than the immense size of the blocks composing them. Some of the stones, of an oblong shape, are from 10 to 15 feet in length, and 5 or 6 feet thick. Their sides are quite smooth; but though square, and of pretty regular formation, they bear no mark of the chisel. They are laid together *without cement.*"† And in the account of the remarkable colossal remains in Easter Island, the same very singular circumstance is observable. "These monuments consist in a number of terraces or platforms built with stone, cut and fixed with great exactness and skill, forming, *though destitute of cement*, a strong durable pile. On these terraces are fixed colossal figures or busts. They appear to be monuments erected in memory of ancient kings or chiefs."‡ Although many of the South Sea Islands consist of vast masses of coral, and are surrounded with coral reefs, the natives never had in any instance learned the art of burning the coral into lime; and when taught the process by the missionaries, they testified alike their astonishment and delight. The colossal terraces, I may add, are exactly similar to those described and figured by Stephens in his account of the ruined Indo-American cities of Copan, Palenque, and Uxmal. I quite agree, however, with Mr. Stephens in regarding these cities as of a comparatively modern date, and as having been inhabited in all likelihood down to the era of the Spanish conquest; first, because there are wooden lintels still remaining in some of the ruinous buildings; and, secondly, because the walls are cemented with mortar, and covered with stucco. For in the more ancient buildings of that continent, as on the shores of the Lake Titicaca, in Peru, there is no cement used. Spanish writers describe the remains of an ancient Peruvian temple, con-

* The Giant Cities of Bashan; London, 1867, page 26.
† Typee, page 173.
‡ Ellis's Polynesian Researches, iii., 326.

sisting of an enclosed space, open at the top, of which the walls are about 12 feet in height, and consist of stones of an immense size, some of them being 30 feet long, 18 broad, and 6 feet thick. *These stones are not cemented with mortar;* neither have they been squared to join closely to each other, like hewn stones in a European building, although the stones of ancient Peruvian buildings are sometimes found hewn into regular forms; but cavities have been wrought with the utmost exactness, and with incredible labour, in one stone to receive the natural or accidental protuberances of another.

Tumuli, constructed, in some instances, of immense stones, and in others, as on the banks of the Ohio, of mounds of earth, are also found among the remains of ancient civilisation, both in the South Sea Islands and in America. I have already mentioned the tomb of Toobo Tooi, in the island of Tonga, constructed of immense stones that must have been rafted across the sea from some other island, as Tonga is a mere mass of coral, and perfectly flat.

Remains of ancient and regular fortifications have also been discovered in both continents of America; and the circumstance has repeatedly awakened much curiosity respecting the origin, the history, and the fate of the nation that has left behind it these memorials of its ancient civilisation. But regular fortifications of a similar kind are still met with in all parts of the South Sea Islands. In some islands they are constructed of walls of loose stones piled on each other on the tops of hills, as in New Zealand; in others, as in Ascension Island, in the Northern Pacific, of a wall of 30 feet high, enclosing a harbour, and formed of large blocks of dressed stone, built up with great architectural skill, but without cement of any kind; in others they are formed of strong palisades, like the Burman Stockades, as in the level island of Tonga; and in others still they consist of some artificial addition to a place of great natural strength, as in the district of Atehuru, in Tahiti. In short, the South Sea Islanders have evidently been in a sufficiently advanced state of civilisation to enable them to construct fortifications, and to adapt these fortifications, in regard to the materials employed in their construction, to the nature of the country in which they were required. This part of our subject is so very interesting that I shall willingly avail myself of the following passage from Mr. Ellis:—

"The fortress at Maeva, in Huahine," one of the Society Islands, "bordering on a lake of the same name, is probably the best artificial fortification in the islands. Being a square of about half a mile on each side, it encloses many acres of ground well stocked with breadfruit, containing several springs, and having within its precincts the principal temple of their tutelar

deity. The walls are of solid stonework, in height 12 feet. They are even and regularly paved at the top. On the top of the walls (which in some places were 10 or 12 feet thick) the warriors kept watch and slept. Their houses were built within, and it was considered sufficiently large to contain the whole of the population. There were four principal openings in the wall, at regular distances from each other, that in the west being called the King's road. They were designed for ingress and egress; but during a siege were built up with loose stones, when it was considered a *pari haabuca*, an impregnable fortress."*

Considering that the normal state of the South Sea Islands has from time immemorial been that of civil or rather internecine war, there is no point of comparison between the Polynesians generally and the Indo-Americans more interesting than that of their fortifications. Those of the Indo-Americans appear to have been generally formed of mounds of earth—a mode of formation well adapted for such localities as the alluvial banks of the Ohio, the dead levels near the lakes of Canada, or the elevated plains of Central America, but not at all adapted for the South Sea Islands. My talented townsman, the late John Galt, Esq., of Greenock, Scotland, the author of a whole series of popular works of fiction about half a century ago, and father of the late Premier in Canada, has told me that he had seen the remains of an Indian fort on the summit of a precipitous ridge near Lake Simcoe, in Upper Canada. It consisted of a mound of earth, enclosing a considerable extent of ground; but on the banks of the Miamis River, much farther to the southward, the Indian forts had been constructed of stone.

Nay, the march of ancient civilisation among the Indo-Americans may even be traced, in some measure, by those most interesting remains. In South America I have not heard of their being found to the eastward of the Andes. The gloomy forests of Guiana and the Brazils were evidently unfavorable for the preservation of Indo-American civilisation; and the portion of the race that wandered into these vast solitudes was necessarily broken up, at an early period, into an infinity of insignificant tribes that could hold little or no communication with each other, and that, consequently, very soon sunk irrecoverably beneath the level of the rest of their nation. But the regions of Central America, the elevated plains of Bogota and Cundinamarca, the open valleys of Peru, and the lofty and secluded but highly fertile tracts of Chili, were much more favorable for the formation of powerful states and empires; and it is, accordingly in these portions of the continent of South America that the ruins of ancient cities and of extensive fortifications are found. In the North American continent, the course of the Mississippi and its tribu-

* Ellis: Polynesian Researches iv, 459.

tary streams would, doubtless, guide the Indian in his progress to the northward; and it is, accordingly, on the banks of the Ohio, in the Western prairies, and along the lakes of Canada, that we find the monuments of his ancient power.

There is therefore a remarkable similarity in the developments of civilisation in the article of national defences or fortifications, on the part of the Indo-American nations and the Polynesians respectively. One is constrained to regard them as the same people, exhibiting, as they do, in circumstances remarkably different, the same amount of intellectual power and mechanical ability. There are certainly no such palatial residences to be found in the South Sea Islands as those of which we find the ruins in the Indo-American cities of Central America and Yucatan. But the reason is obvious—the South Sea Islands afforded no such fields for the establishment of mighty empires, the exercise of kingly power, and the other developments of luxury, as there were in Mexico and Peru and Central America. But I maintain, without fear of contradiction, that there is nothing in the civilisation of these Indo-American empires of the past that is not fairly traceable to a Polynesian source.

II. I now proceed to the second branch of our subject—to show that the phenomena of language, and of what may be called literature among the aborigines of America, point directly to a Polynesian origin.

Taking it for granted, therefore, that the theory I have been endeavoring to establish, is well founded, and that America had been originally discovered by a handful of Polynesians from Easter Island, who had been caught suddenly, when perhaps fishing off the coast of that island in one of those violent westerly gales that are so prevalent in the Southern Pacific, and had been driven before the wind to the American land, what are the phenomena in regard to language which this theory would lead us to anticipate—supposing as I have done that the forefathers of the Indo-American race in both continents had landed on the west coast of South America, somewhere near Copiapo, in the Republic of Chili, and that the future migrations of their descendants, north, east, and south, had commenced from that point? Why, we should expect, as a matter of course, that the Polynesian character of the language or languages spoken by the Indo-American people would be retained the most strongly in the region in which the forefathers of the race had first landed. Now this is precisely what we find to be the actual fact. De Zuniga, the historian of the Philippine Islands, a most unexceptionable witness in such a case, informs us that the words of the language of the Araucanian Indians of Chili, contained in the work of Erçilla, the historian of that people, are strikingly conformable, *bastante conformes*, to those of the language of Tagala, one of the districts of the

Philippines. I may add, in passing, that one of our own respected members, Mr. Edward Hill, who spent four years of his life in sailing among the South Sea Islands, and who knows, perhaps, more about their inhabitants than any other person in this Colony, while he coincides with me entirely in regarding these islanders as Malays from the Indian Archipelago, conceives that the Philippine Islands were their starting point from that Archipelago, and that, to use the nautical language, they made their easting in the Northern hemisphere, but in that Equatorial belt, in which La Perouse and Admiral Hunter inform us that at certain seasons of the year westerly winds are as prevalent as easterly.

We should also expect if my theory is well founded, that the Indian languages of South America generally, down to the Equator, would exhibit much more of the Polynesian and vocalic character than those of the northern continent, the latter being so much farther from the original point of departure. And this is precisely what we find in fact. Whole strings of words in the language of the Indians of the British province of Guiana, whole strings of words in the language of the Cuna Indians of the Isthmus of Darien, are in their form and character precisely like so many words in the Polynesian dialects of New Zealand and Tahiti.

A scholar, accustomed to trace the affinities, or to detect the radical dissimilarity of different languages, would at once unhesitatingly assert that the following words of the dialect of the Warows, of British Guiana, were just so many words of the Polynesian tongue:—

Head	Magaah	Water	Ho
Eyes	Maamu	Earth	Hotah
Mouth	Maroho	Sun	Yah
Hair	Maaheo	Moon	Waanehah
Ears	Mahohoko	Stars	Keorah
Arms	Mahaara	Thunder	Nahaa
Skin	Mahoro	Rain	Naahaa
Blood	Hotuh	Paddle	Haahah

The following words are from the dialect of New Zealand:—

Mahana	Day	Madino	Smooth
Marama	The moon	Maha	Much
Maripi	A sword	Matapo	Blind

N.B.—The syllable Ma, in both lists, is in all likelihood a prefix.

The following Indian names of localities on the Demerara River, supplied me by a friend returned to England from Demerara, have also quite a Polynesian aspect:—Arigaraboe, Hiagua, Haboe, Boera-boera-wa, Warawarau, Maraka, Mamaa, Moenetari, Mari Mari, Winipio, Mamikoeroa, Toematamatia, Motolca, Akyma, Kaiwalia, Kamakaiaha, Dalawila, Wai, or Vai, is the Polyne-

sian word for water; and Waridu, Waratili, Walaba, are the names of three creeks that empty themselves into the Demerara River.

The following specimens of the language of the Cunas, one of the tribes of Indians inhabiting the Isthmus of Darien, have also very much of a Polynesian aspect. I extract it from "The Journal of the Royal Geographical Society for the year 1868," page 100.

Father	Tata
Mother	Nana
	Nusatileli Nana, Nusatileli's mother
Brother	Urpa
Sister	Orne
Son	Hilu
Man, or men	Tule
Water	Ti
Canoe	Ulu. Look to the canoes—Ulutaque
Paddle	Canie. Take care of the paddles—Canie pehue taki.
Black	Rati
Red	Kiniti
High	Tumati
Ill, evil	Chuli
I, me	Anu
You, thou	Pe
Day	Yppa
Evening	Sueto
Rice	Aro
Flesh	Sána
Needle	Ico, yco
Bench, seat	Cána
Dish, plate	Náala
Calabash	Noga
Yes	Ee (nasal)
No, nothing	Chúle
Who	Ipi
Where, wheu	Pia mai
To take	Káe
To see	Take
To have	Nica
What have you?	Ipi pe nica
To tell	Shogue. Tell him—Pe shogue.
To know	Huishi
To go	Nae. Go (imper.), Pe nae.
Pain	Nun maké
One	Kuasak
Two	Pagua

Three	Pa
Four	Pake
Five	Atal
Six	Nerkua
Seven	Kugule
Eight	Pavaga
Nine	Pakewake

De Zuniga also observes, in the passage of his work which I have already quoted, that "the proper names of places, about the middle of the continent of South America, are very similar to those of the Philippines."

The following are a few of these names of places in South America having a Polynesian aspect:—Peru, Quito (Kito), Guatimala (Katimala), Arica, Loa, Titicaca, Panama, Huayna, Chili, Caicara, (Kaikara), Alahualpa, Tiahuanacu, Arequipa (Arekipa), Guarohiri (Karohiri), Huanuco, Lima, Tarapaca, Guana Xato (Kanahato), &c. The same Polynesian character of the language also holds in regard to persons even in Mexico. For example, the Mexican reverential affix *tzin* or *azin*, which was always added to the names of princes, is in all likelihood the Indo-Chinese affix, *asyane*, signifying lord, if not rather the Chinese word *tsin*. In the list of Mexican kings who reigned previous to the era of the Spanish conquest we find the names of Nopal-tzin, Ho-tzin, Quina-tzin (Kina-tzin), Cacoma-tzin, Cuicuitzca-tzin, Coanaco-tzin, Montezuma-tzin, Guatimozin (Ka-Tima-tzin). Several of these proper names have a remarkable resemblance to modern Polynesian names; the last especially—the name of the unfortunate prince whom the Spaniards extended over a fire of coals to compel him to inform them where he had hidden his treasures—that name is, when stripped of its Spanish doublet and its reverential affix, a pure New Zealand name.

When we reach the northern continent, however, in which the movement of nations, wars, and conquests would seem to have been much more frequent than in the South, the Polynesian or vocalic character of the language disappears, and we meet with combinations of consonants of a really formidable character, altogether unlike the speech of Polynesia. The Aztecks, or modern Mexicans, who had overrun the Mexican territory from the northward, and whose tenth king, Montezuma, was the reigning monarch at the era of the Spanish invasion, ascribed the erection of the famous pyramid of Teotihuacan to the Toltecks, a tribe of kindred origin and language, who had also overrun Mexico, five hundred years before the Azteck conquest; but they did so simply because their chronology, which, like that of many other conquering tribes, overlooked the records and traditions of the vanquished people, did not extend any higher than the era of the migration and conquests of the northern tribes.

But the probability is that the pyramid of Teotihuacan was erected long before the Toltecks had emerged from the forests of the North, and that that warlike but less polished race retained the ancient Polynesian name of the stupendous edifice, while they worshipped their own national divinities within its sacred precincts, under their own northern appellations. At all events there is a wonderful difference in character and aspect between the Polynesian name Teotihuacan and those of the Azteck and Tolteck divinities *Huitzilopochtli*, the god of war, and *Mictlancihuatl*, the goddess of hell.

I have already quoted the strongly expressed opinion both of Humboldt and of Dr. Von Martius, that the Indo-Americans are all one and the same people, from north to south, with no intermixture with any other portion of the family of man. Baron Humboldt also apprises us of the very interesting fact that notwithstanding the wonderful diversity of language among the aborigines of America there is a common principle of mechanism exhibited in the structure of all the aboriginal languages of that great continent which entitles us to refer them all to one common origin. "Languages," says that illustrious writer, "are much more strongly characterized by their structure and grammatical forms than by the analogy of their sounds and of their roots; and this analogy of sounds is sometimes so disfigured in the different dialects of the same tongue as not to be distinguishable; for the tribes into which a nation is divided often designate the same object by words altogether heterogeneous. Hence it follows that we are easily mistaken, if, neglecting the study of the inflections, and consulting only the roots—for instance, the words which designate the moon, sky, water, and earth—we decide on the absolute difference of two idioms from the simple want o resemblance in sounds."* "From the country of the Esquimaux to the banks of the Oroonoko, and again from these torrid banks to the frozen climate of the Straits of Magellan, mother-tongues, entirely different with regard to their roots, have, if we may use the expression, the same physiognomy. Striking analogies of grammatical construction are acknowledged, not only in the more perfect languages, as that of the Incas, the Tymara, the Guarani, the Mexican, and the Cora, but also in languages extremely rude. Idioms, the roots of which do not resemble each other more than the roots of the Sclavonian and the Biscayan, have those resemblances of internal mechanism which are found in the Sanscrit, the Persian, the Greek, and the German languages. It is on account of this general analogy of structure—it is because American languages, which have no word in common (the Mexican, for instance, and the Quichua), resemble each other by their organization, and form complete contrasts with the languages of

* Humboldt, *ubi supra*.

Latin Europe, that the Indians of the missions familiarise themselves more easily with an American idiom than with that of the metropolis. In the forests of the Oroonoko I have heard the wildest Indians speak two or three tongues. Savages of different nations often communicate their ideas to each other by an idiom which is not their own."*

Another extraordinary coincidence in the civilisation of the Indo-Americans with that of Polynesia presents itself in the fact of there having been in both a language of ceremony, distinct from the language of common life. I have shown in my first lecture that there was such a language, not only among the Indo-Chinese nations of Eastern Asia, but in Polynesia also, especially in the larger islands and among the more advanced tribes, as in Samoa and Tahiti; as, for instance, when inferiors addressed their superiors, when a plebeian addressed a chief, or when the latter addressed his prince. This language of ceremony did not consist in the use of a few phrases of deference and respect, such as those in use in European languages, in addressing royalty or nobility. It constituted, so to speak, a separate language, and pervaded the whole economy of speech. "The Mexicans," says Dr. Robertson, when alluding to the singular circumstance, which he had no idea of its having ever obtained or been observed among any other people,—"The Mexicans had not only reverential nouns, but reverential verbs;" and the use of any other than this reverential language in conversing with a king or higher chief would, both in Mexico and in Tahiti, have been held tantamount to high treason. This feature of resemblance between such widely dissevered portions of the human family is surely of such a character as not to be mistaken for a mere accidental coincidence; it constitutes rather an evidence of the absolute identity of the Indo-American and Polynesian nations that cannot be gainsaid.

The right of property was recognised and established among the Indo-American nations; but the lower orders generally cultivated a considerable extent of ground in common, the produce of which was laid up in storehouses, called *tambos*, and distributed at certain periods, agreeably to some established custom. Now it is very remarkable that the practice of the New Zealanders was precisely similar. The kumaras, or sweet potatoes of that island, are always cultivated *pro bono publico* by persons set apart for the purpose; the produce being afterwards distributed according to rule. The storehouses in New Zealand are always *taboo*, the violation of which by any person is death. I suspect the Spaniards have either reported the word inaccurately, or disguised it a little with their peculiar pronunciation; for the Mexican *tambo* is unquestionably the same word as the Polynesian *taboo*, as they both signify the same thing.

* Humboldt, *ubi supra*.

Perhaps, however, the most remarkable feature in the civilisation of the Indo-American nations was their picture writing and their hieroglyphics; by which they were enabled to transmit to posterity a knowledge of the memorable events of successive ages. The progress made by the Mexicans in these arts of a higher civilisation was truly wonderful, and the long columns of hieroglyphics carved in stone on their colossal monuments, and resembling in some measure the hieroglyphics of ancient Egypt, carry us back, as almost everything else does in Indo-American civilisation, to the remotest period in the history of man. Unfortunately there has as yet been no Champollion, as in Egypt—no Rawlinson, as in Assyria—to interpret these wonderful remains of an extinct civilisation; but although there are no such remains as the picture writing of the ancient Mexicans in the South Sea Islands, it is quite evident that the Polynesians were on the right track towards the much higher level of the chroniclers and the picture writers of Mexico, and that all that was wanting for the development of their idea was a suitable field, which the comparatively narrow limits of the South Sea Islands and their small population did not present. "Along the southern coast of the Island of Hawaii," says Mr. Ellis in his Polynesian Researches, "both on the east and west sides, we frequently saw a number of straight lines, semi-circles, or concentric rings, with some rude imitations of the human figure, cut or carved in the compact rocks of lava. They did not appear to have been cut with an iron instrument, but with a stone hatchet, or a stone less frangible than the rock on which they were pourtrayed. On inquiry, we found that they had been made by former travellers, from a motive similar to that which induces a person to carve his initials on a stone or tree, or a traveller to record his name in an album—to inform his successors that he has been there. When there were a number of concentric circles with a dot or mark in the centre, the dot signified a man, and the number of rings the number of the party who had circumambulated the island. When there was a ring, and a number of marks it denoted the same, the number of marks showing of how many the party consisted, and the ring, that they had travelled completely round the island; but when there was only a semicircle it denoted that they had returned after reaching the place where it was made."

I am inclined to differ from Mr. Ellis when he regards these rude specimens of picture writing as the first efforts of an uncivilised people towards the construction of a language of symbols. I am inclined to regard them, in common with those colossal remains of the architecture of the earlier Polynesians, which their degenerate offspring of the present day can only behold with amazement, rather as the scanty but interesting relics of an ancient and primitive civilisation, of which both the

memory and the evidences have almost passed away. In short, it appears to me incontestible that the practice of picture writing was in general use among the earliest inhabitants of the South Sea Islands; but that in the course of exterminating wars, or rather in consequence of that rust which gathers over the human mind when it is cooped up within a narrow sphere, and thereby loses the edge and the polish which it acquires by being frequently rubbed upon the whetstone of society, this and various other Asiatic arts were gradually lost.

It is natural, however, to suppose that the impression which had once been made upon the Polynesian mind, but which had thus been well nigh effaced, from the causes I have enumerated, in the South Sea Islands would again be revived and deepened on the plains of Quito, and around the Lake of Mexico; just as a writing in sympathetic ink becomes darker and more distinct when held close to the fire.

The Indian nations of North America had carried this, as well as the other arts, and the general civilisation of its central regions, as high as the lakes of Canada. When that province was colonised by the French the most powerful Indian nation in North America was the Iroquois—a nation which it afterwards required many a fierce battle to exterminate. That warlike nation was sufficiently civilised at the period I refer to, to practise the Mexican art of picture-writing; for an Indian village, situated somewhere near the site of the present city of Montreal, having about that period been surprised and destroyed by the French, a painting or picture-writing, which afterwards fell into the hands of the French, containing a hieroglyphical representation of the event, was executed by some Indian artist, to transmit an account of it either to the distant tribes of the nation or to posterity. The village was indicated by a series of wigwams, and the state in which its inhabitants were surprised, by an Indian asleep. The rising sun indicated that the attack had taken place at the break of day; and the moon in her first quarter on the back of a stag, afforded the additional information that it had taken place in the early part of that month in the Indian year of which the stag was the emblem.

In a letter to the Secretary of the Antiquarian Society, published in the sixth volume of the Archæologia, W. Bray, Esq., gives an account of an Indian picture-writing which had been intended to commemorate the exploits of Wingenund, an Indian warrior of the Delaware nation, about the middle of last century. It consisted of a series of marks or characters inscribed within a square figure on a sugar-maple tree on the Muskingham River, in the State of Delaware. The first line consisted of the figure of a turtle—the emblem of the tribe to which the warrior belonged —an arbitrary mark designating the particular chief who had

executed the writing, and a representation of the sun. Ten horizontal lines on the right side of the figure denoted the number of expeditions in which the warrior had been engaged; and opposite to each of these lines on the left there was a series of marks resembling the letter X, with a bar across the top of it, representing the number of scalps or of prisoners he had taken; the sex of the victim being designated by a slight variation of the character, and the central part of the figure being occupied with a rude drawing of three different British forts which he had attacked on these occasions. At the bottom of the figure there were twenty-three vertical lines inclining a little to the left (the figure of the sun in the first line of the writing being at the right side of the painting) to denote that at the time the record was left the writer was marching on another expedition to the northward.

So far north, even, as the Hudson's Bay Territory, this method of communication by picture-writing prevails among the wild Indians of that inhospitable region. The Rev. John West, one of the Hudson's Bay Company's chaplains, on travelling in the Red River colony in the year 1820, came up with an Indian family who proposed accompanying him to the factory. "The Indian had two sons, who, he said, were gone in the pursuit of a deer; and on quitting the encampment to travel with us he would leave some signs for them to follow us on their return. They were drawn upon a broad piece of wood which he prepared with an axe. They were—1st. A tent struck to intimate that the party had gone forward in a particular direction; 2nd. Four rude figures indicating the number of the party, and exhibiting by their dress and accoutrements the rank or condition of each individual, viz., a European chief, a European servant, and Indian attendant, and the two Indians from the encampment. 3rd. A curvilinear figure with the two extremities of the curve pointing towards the hindermost of the figures, to intimate to the Indian's two sons that they were to follow the party." *

The development of this rude method of communication into the famous picture-writing of Mexico was a natural process to be expected in the progress of society in the large wealthy capital of a great empire like that of Montezuma.

The same remark holds good also in regard to the astronomical knowledge exhibited in the remains of the ancient Mexicans. The germs of that knowledge existed in Polynesia, and only required a suitable field for its development; for my friend Mr. Edward Hill informs me that the South Sea Islanders have, in certain islands, at least sufficient astronomical knowledge to steer their course by the stars.

* The substance of a journal during a residence at the Red River Colony; by John West, M.A., London, 1824.

Part III.

I now proceed to the third and last department of our inquiry, viz., to show that the same singular manners and customs, altogether unlike those of the rest of mankind, are observable alike among the wilder tribes, both of the Indo-Americans and the Polynesians.

Before mentioning any of these, I would remark upon the great resemblance in bodily form that has been observed by intelligent travellers, in comparing one of these tribes of mankind with the other. Speaking of the Indians of Acapulco in Mexico, on the Pacific coast, Captain Basil Hall, R.N., thus writes :—"Their features and colour partake somewhat of the Malay character; their foreheads are broad and square; their eyes small, and not deep-seated; their cheek-bones prominent, and their heads covered with black straight hair; their stature about the medium standard, their frame compact and well made."*

One of the most remarkable peculiarities in the manners and customs of nations is their different modes of disposing of the dead. On one of my voyages to England, in the year 1839, our good ship having sprung a leak a few days after leaving this port, we had to run for repairs to the Bay of Islands, in New Zealand, where we lay about ten days, shortly before the colonization of the New Zealand group had commenced. During my stay I visited the cemetery of the Bay of Islands tribe, situated close to the native village of Kororarika. There were no graves, however, to be seen in the cemetery; the dead bodies having each been wrapped up in mats, and laid upon trestles raised a few feet from the ground, and left to putrefy in the open air. During the following year, before my return to the Colony, I happened to visit the exhibition of American Indian curiosities of a Mr. Catlin, an American gentleman, of a very enthusiastic and adventurous character, who had been travelling for many years among the wild Indians of that country, and with whose family I had in the meantime become acquainted in New York; his wife, whom he had left behind him in the United States, having been entrusted to my care on her passage across the Atlantic to rejoin her husband in London. On one of my visits to Mr. Catlin's exhibition in the Egyptian Hall, London, I happened to see an interesting drawing, or rather painting, which he had made on the spot, of the native village of the Mandan tribe of Indians in Missouri, and I was greatly struck at observing that the cemetery of the village had precisely the same singular appearance as that of the New Zealand native cemetery I had seen a few months before at Kororarika, in the

* Captain Basil Hall's Voyage to South America, vol. ii., page 175.

Bay of Islands; the dead bodies in both cases having been wrapped up in mats and laid on trestles raised a few feet above ground. I afterwards found, however, that this was the usual mode of disposing of the dead among the wild Indians of America, so far north even as the Red River Colony in the Hudson's Bay Territory, as witness the following quotation from the journal of the Rev. Mr. West, already quoted above:—

"On the following morning I saw an Indian corpse staged, or put upon a few cross sticks, about 10 feet from the ground, at a short distance from the fort. The property of the dead, which may consist of a kettle, axe, and a few additional articles, is generally put into the case, or wrapped in the buffalo-skin with the body, under the idea that the deceased will want them, or that the spirit of these articles will accompany the departed spirit in travelling to another world."*

On the occasion of my visit to the cemetery at Kororarika I observed two other customs or practices of the South Sea Islanders, indicating, together with that of keeping the dead above ground, an Egyptian or contemporary origin, as ancient at least as that of the sojourn of the children of Israel in Egypt. There happened during my visit to be one of those periodical mournings for the dead in progress which are symptomatic of a similar origin. A number of native men and women were assembled in the cemetery—the former for the most part strongly tattooed, while the latter were ever and anon cutting themselves with mussel-shells till the blood streamed down from their cheeks as they gazed intently at the remains of the deceased; for one of the mummy-cases having in the meantime been taken down from the trestle and opened, the bones of the deceased—in all likelihood those of a superior chief, long deceased—were spread upon a mat on the ground; the ceremony being occasionally relieved with sudden bursts of dismal and unearthly wailings and howlings in honor of the dead. Now, it is worthy of remark, as a confirmation of my theory as to the extreme antiquity of the Polynesian and Indo-American races, that both of these savage practices—tattooing and cutting for the dead—which were doubtless common in ancient Egypt and among the earlier post-diluvian nations, were expressly forbidden in the laws of Moses to the children of Israel, as we find in the Book of Leviticus, chap. xix. 28: "Ye shall not make any cuttings in your flesh for the dead, nor PRINT ANY MARKS UPON YOU; I am the Lord." The practice of tattooing has all along been a national practice among the South Sea Islanders, although long disused in some of the islands; and the Rev. Mr. West informs us that it is still occasionally observed among the Indians of Hudson's Bay.

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* "Journal of a Residence at the Red River Colony, British North America"; by John West, M.A.

There are various other practices or observances common to the Polynesians and Indo-Americans which I shall merely enumerate without dwelling upon them at any length. The necessity for *utu*, or satisfaction for any injury received, and the cherishing of feuds arising in this way for generations, is equally distinctive of the New Zealanders and the Indo-Americans, especially those of the northern continent. The manufacture of an intoxicating beverage from a root, called in the South Sea Islands cava, and in the equatorial regions of America cassava, evidently the same word, is equally common to both, as well as the very singular and disgusting mode of its manufacture; the root being chewed in some instances by boys, in others by young women, and in others again, as among the Cunas at the Isthmus of Darien, by old women; the residuum being collected in a large vessel and water poured over it, thereby inducing fermentation. The mode of catching fish also by throwing an intoxicating herb or root into the water; the separation of women, and prohibiting them from touching their food with their own hands for a certain time after childbirth, and the caste of blood being transmissible through the female and not through the male, are also equally common to both of these very ancient races of the family of man.

I have thus shown, I trust to the satisfaction of the Society, that the forefathers of the Polynesian race were separated from the rest of mankind, in the very infancy of the post-diluvial world, in the remotest ages in the history of man. I have also shown that at the period at which this separation took place, the world must have been in a comparatively advanced state of civilization, implying at least very considerable skill in the arts of life, and great ability in the use and management of the mechanical powers. I have shown, moreover, that the impression of this primitive civilization must have been photographed, so to speak, on the Polynesian mind, to be reproduced wherever they went, in every suitable field. I have likewise shown that after having crossed over almost the whole extent of the broadest part of the Pacific, the amphibious islanders reached at length the farthest east of the inhabited islands of that ocean, viz.:—Easter Island, in latitude 27·6 S., and that from that island, which is only about 2,000 miles from the west coast of America, a mere handful of unfortunates must have been caught suddenly in one of those violent westerly gales that are so frequent in the Southern Pacific, and been blown across the intervening tract of ocean to the American land—landing somewhere in the State of Chili near Copiapo, in the latitude of Easter Island. And I have expressed my own opinion very strongly that this arrival of a few famished Polynesians on the west coast of America must have taken place some time between twelve and fifteen hundred years before the birth of Christ; that is some time between the death

of the patriarch Jacob and the exodus of the children of Israel from the land of Egypt. A later date than this would scarcely suffice to account for the dispersion of the Indo-American nations over both continents, originating as they all did, agreeably to the testimony of Baron Humboldt, in one common source, as well as for the multitude of languages that have sprung in the course of long ages from that one source.

I maintain, further, that the original inhabitants of America, and their more immediate descendants, had brought along with them, from beyond the Pacific, a comparatively advanced form of civilization, which they reproduced in those colossal works of which the wonderful remains in Peru and Mexico have astonished the whole civilized world; but that this higher civilization had, from causes unknown to us, died out long before the era of the Spanish conquest. Dr. Von Martius, who maintains that the Indo-Americans are indigenous, created on the spot as an inferior edition of the genus man, and having no connection or relationship with any other portion of the human family, nevertheless admits the fact of this higher civilization having characterized the earlier ages of Indo-American history. "Colossal works of architecture," he tells us, "comparable in extent to the monuments of ancient Egypt (as those of Tiahuanaca on the Lake Titicaca, which the Peruvians, as far back as the time of the Spanish conquest, beheld with wonder as the remains of a much more ancient people), bear witness that their inhabitants had in remote ages developed a moral power and mental cultivation which have now entirely vanished. A mere semblance of them—an attempt to bring back a period which had long passed by—seems perceptible in the kingdom and institutions of the Incas."

It would appear, therefore, that long ages, perhaps, before the era of the Spanish conquest, a blight had fallen on the earlier and higher civilization of the Indo-Americans, and that it had, in a great measure, died out, as it would seem to have done completely all over the Pacific. But if we only take into considertion the remarkably peculiar circumstances in which the Indo-American nations were placed, as compared with the nations of the West, we shall not be surprised at this seemingly mysterious consummation. What other division of the human race would, in similar circumstances have attained a higher level than the Indo-Americans appear to have reached? Had Europe, for instance, been inhabited exclusively either by the Celtic or the Teutonic race for the last three thousand years—had that race been shut out from all communication with the rest of mankind—had they been equally ignorant of letters and of the use of iron—and had their only domestic animals been the dog, the turkey, the llama, and the duck, with no sheep or cattle or horses, or swine, and had their only species of grain been maize or Indian corn—I question

whether Europe itself would have vied at this moment with ancient Mexico or Peru. The nations of the West have in all past ages been jumbled together in the great political dice-boxes of Europe and Western Asia, each perpetually changing its relative position to the rest, and entering from absolute necessity into new combinations. Now, just as quartz pebbles lose their angles and acquire a sort of polish by being subjected to the rushing of waters in the bed of a rapid river, while they would doubtless have retained their original conformation and their less pleasing exterior if they had been lying all the while at the bottom of a lake—and as malt liquor, when it has become stale, revives and becomes brisk again when emptied from vessel to vessel—it appears to me that the changes of circumstances that have been experienced in all past ages by the Western nations, have been highly favourable to the general progress of civilization in the West, and to the general development of the mental energies of man. In short, when we consider the very unfavourable circumstances in which the Indo-American nations had been placed for countless ages, and contrast them with the stately ruins of their palatial and other noble buildings that indicate their past glory, the wonder is not that the Indo-Americans achieved so little, but that they achieved so much.

At all events, there is evidently a very wide field still open to the Australian literati of the future in tracing the developments of human society in such extraordinary circumstances as present themselves to the contemplative mind in the South Sea Islands, and among the Indo-American nations.

ON THE DEEP OCEANIC DEPRESSION OFF MORETON BAY.

By Rev. W. B. Clarke, M.A., F.R.S., F.G.S., &c.

[*Read before the Royal Society*, 20 *July*, 1876.]

During the year 1875 I had the honor of laying before this Society, in my Anniversary Address, an account of the scientific researches carried on by Captain Nares, R.N., and the officers of the Scientific staff on board H.M.S. "Challenger," supplemented afterwards by "Notes" founded on reports of subsequent observations by Captain Thomson, R.N., who succeeded Captain Nares on the occasion of that officer's appointment to the command of the Expedition to the Arctic Ocean.

The topics treated of in my Address had reference principally to the Atlantic Ocean, with only scanty notices of the Pacific. The supplementary notes had more special allusion to the Pacific and the seas connected with it, and discussed Dr. Carpenter's deductions from some of the observations and experiments made by Captain Belknap on board the United States steamer "Tuscarora," in those parts of the Pacific with which we are more particularly interested.

Since that paper was read, in December, 1875, the "Tuscarora" arrived in Port Jackson, and I lost no time in visiting her then commander, Captain Miller, who had been commissioned by the United States Government to make researches, not on the extensive scale undertaken by the "Challenger," but chiefly for a safe submarine telegraph line to Fiji and New Zealand.

I was received very kindly by Captain Miller, and having learned the interest I took in such researches, he gave me satisfactory information and showed me the results as placed upon the chart. On requesting to be furnished with an Abstract of soundings from Fiji to Australia, it was courteously accorded by Captain Miller, who asked me to make no public announcement till after the middle of April, as he very properly wished his communication to be sent to the American Government.

In reserving my notice of the "Tuscarora's" work till the month of July I have not transgressed the limits to which her commander's permission extended. The particulars to be mentioned do not, however, include that portion of the intended line which would have connected Fiji with New Zealand, because, on its being known that a cable had been laid between that country

and this, that part of the "Tuscarora's" work was countermanded, and therefore no comparison can be instituted between the line now in operation and the one intended by the United States. After a brief stay in these waters, the "Tuscarora" sailed, as I understood, for San Francisco; but I believe she had not reached that port at the date of late advices.

I consider it only right to offer this explanation to the Society before I mention the contents of Captain Miller's communication, which is, though brief, of considerable importance, as pointing out some peculiarities in the ocean bed off the southern part of the coast of Queensland.

It is to be borne in mind that the instruments on board the "Tuscarora" were not of the elaborate character of those on board the "Challenger," some of which in operation I had the pleasure of witnessing in a dredging excursion off this coast; but they appeared to me to be amply sufficient for the purpose intended. Nor were there any means of obtaining the information so diligently sought for, as to the inhabitants of the deep ocean, by Professor Thomson and his able assistants. Nevertheless, Captain Miller had collected some interesting objects for future examination.

Abstract of Soundings for Submarine Cable between Kandavu Island, Fiji Group, and Brisbane, Queensland, obtained by Commander Miller, in U.S. steamer "Tuscarora."

Date.	No. of Cast.	Lat.	Lon.	Depth in Fathoms.	Nature of bottom.	Remarks.
1876 Jan.		S.	E.			
25	76	19·11	177·41	1647	Yel-br. ooze	Position taken from bearings in British Admiralty Chart, No. 2,691.
	77	19·29	176·53	1915	Yel-br. ooze and coral.	
26	78	19·46	176·10	1723	No specimen	Stray line fouled cylinder.
	79	20·04	175·24	1763	Br. ooze and blk. sand.	
	80	20·21	174·42	1625	Br. ooze and sand.	
27	81	20·44	174·00	1460	Ditto.	
	82	21·03	173·22	1875	Coral.	
	83	21·20	172·35	1950	Br. ooze and sand.	
28	84	21·35	171·48	1372	Coral	Small specimen.
	85	21·48	170·56	1398	Br. ooze and sand.	
29	86	21·58	170·13	2165	Ditto	Small specimen.
	87	22·11	169·25	1627	White coral and sand.	
	88	22·36	168·52	747	Coral and lava ...	Off Walpole Island.
30	89	22·54	168·11	1009	White coral.	
	90	23·05	167·40	483	Coral and shells...	Isle of Pines in sight.
	91	23·16	167·09	460	Hard coral.........	No specimen. Cylinder came up flattened.
	92	23·22	166·41	1176	White coral.	
31	93	23·33	165·56	1938	Yel-br. ooze and white coral.	
	94	23·41	165·04	2055	Yellowish ooze.	
Feb. 1	95	23·48	164·19	1400	White coral.	
	96	23·38	163·26	1575	Coral and sand.	
	97	24·35	162·53	930	No specimen	Wire parted reeling in.
2	98	24·58	162·12	615	White coral and sand.	
	99	25·06	161·27	810	Ditto.	
3	100	25·11	160·41	993	White coral and sand.	
	101	25·18	159·52	715	Ditto	To Light-house, Cape Moreton, S. 73° W., 355 miles.*
	102	25·30	159·09	1383	White coral	S. 73° W., 320 miles.
6	103	26·12	156·04	2684	Brown mud	S. 68° W., 149 miles.
	104	26·31	155·07	2682	Ditto	S. 72° W., 95 miles.
9	105	26·03	154·23	2610	Ditto	S. 42° W., 76 miles.
	106	26·18	154·08	2485	Ditto	S. 42° W., 58 miles.
	107	26·32	153·51	562	Brown mud and sand.	S. 42° W., 36 miles.

* N.B.—The bearings to the light-house, Cape Moreton, were measured for me by Captain Hixson.

On reference to my last year's Address it will be seen that the "Challenger," when 30 miles from Kandavu, had a depth of 1,350 fathoms over red ooze. In the "Abstract" we find that the "Tuscarora" had yellow brown ooze, at a depth of 1,647 fathoms, in a position about 30 miles west from Kandavu. The observations from the two ships are therefore so far connected.

It is to be remarked, however, that in the "Tuscarora's" soundings between the Fiji Group and New Caledonia, coral and coral sand frequently occurred, and that the depths were very unequal, only one reaching below 2,000 fathoms, whilst on 3rd February, 1876, at a distance equivalent to 48 miles of latitude, the soundings between the Isle of Pines and Queensland deepened 668, from 715 to 1,383 fathoms, which would give a descending slope much steeper than that on our Western Railway line from its highest point to the sea. Moreover, the depression deepens again in a mean direction of N. 71 E. from Cape Moreton, in Queensland, and, in 225 miles of distance, to a depth of more than three vertical miles from the surface, and this within 95 miles from the Cape; rising again in less than 60 miles to less than three-quarters of a mile in depth in the same general direction.

This proves the existence of a very deep channel, not 100 miles wide, commencing about 36 miles from Cape Moreton. Connecting with the above calculation the "Challenger's" observations, we learn that it does not extend far to the northward, since the ridge from Sandy Cape to New Caledonia, &c., mentioned in my "Notes," cuts it off at about 1,300 fathoms, which is nearly the depth of the north-east slope at about 200 miles distance. This deep channel would therefore appear to have a direction towards that point of the compass. The absence of red clay and ooze from the "Tuscarora's" soundings is curious, but it is in agreement with the general depth assigned to deposits of that colour in the "Challenger's" observations, which occurred below 2,500 fathoms, and there are but three "Tuscarora" soundings between Kandavu and Brisbane exceeding that depth, against which we read "brown mud," "brown," and "yellow-brown," and "white," being the only colours noted outside the Queensland coast depression. It is, however, possible that colours may be variously estimated by different observers, as one of the "Tuscarora's" bottles contained what, to my eyes, appeared to have a reddish tint.

Soundings brought up by H.M.S. "Herald" off Fiji, many years ago, and supplied to me on board by Dr. Macdonald, F.R.S., were filled with *foraminifera*. The colour of the deposit now is a light grey, after long drying in my cabinet. As white coral was dredged by the "Tuscarora" only 320 miles N. 73 E. from Cape

Moreton, the reefs that stud the ocean around the New Caledonia Group extend much nearer to the Australian coast than many persons imagine, and betray the approach to the deep depression just mentioned, the north-eastern edge of which seems to be that of an uneven plateau or ridge in one spot, about 355 miles from Cape Moreton, only 253 fathoms lower than the ocean bed at a distance (on nearly the same bearing) of 36 miles from Cape Moreton. The bottom of the depression is thus about 91 miles wide, on each side of which there is an equal rise and fall of about 41 feet to the mile, and this is about the mean general steepness of the Blue Mountain Range in New South Wales along the railway line, from the summit to the waters of Port Jackson. These calculations are not, of course, given by Captain Miller; but I submit them merely to illustrate the probable slope of the coral reefs towards the west in the area referred to and the contour of the depression.

As the immediate coast of Queensland is comparatively low in the part indicated, this great depression appears contradictory to the usual idea of shoal water off a low coast; but I would explain it, as I do the condition of the sea bottom off the Illawarra coast, as showing a double escarpment with an intervening comparatively level plain or plateau from the mountain summit to the deepest sea bottom. One other inference is that our coast current streams along from the north-eastward over this deep depression and spreads its eddies under the impulse of winds. It would be very interesting to be able to state the depth of water in this current as well as the temperature below it from actual experiments. Judging from what has been determined respecting the Gulf Stream of the Atlantic, which is only 100 fathoms thick, that off our own coast is probably still more superficial. Nevertheless it must have a powerful influence in modifying the climate of the coast region, which is shown by the winter temperature of the water in Port Jackson.*

The depression in question is greater than that between our southern line of coast and New Zealand, as determined by the "Challenger."

* During many years I have made comparative observations (but at irregular intervals, and in various localities, on the ocean in the line of the current) and have found the sea-water generally higher in temperature than the air. I prefer, however, to quote here from a "Comparative table of temperatures of sea-water and air" in Port Jackson, supplied at my request by my excellent and accomplished colleague, H. C. Russell, Esq., Astronomer, from whose data, giving the temperatures for every month in the last six years (1870-1875 inclusive) I collect that the mean for water is 65·1, for air 62·85; and that the maximum for water was 73·6, and for air 73·2; and the minimum for water was 56·1, and for air 51·2—all showing the influence of the ocean water.

The conformation of the part of the ocean-bed off Moreton Bay, as thus explained, is due to purely geological causes, of which the existence is illustrated by the escarpments and ravines yet extant on the land—the ooze and clay and coral sand brought up by the sounding apparatus and dredge being mere submarine superficial deposits, covering and partly filling the bottom of the depression. This analogy of conformation between the depths of the sea and the heights of the land is parallelled by the distribution of life (as has been shown by Dr. Hooker) on the ocean ridges and depths, only in reverse order to that on the land. "The ocean," he says, "thus mirrors one of the most striking features of the distribution of terrestrial life, and, mirror-like, it turns the picture upside down."

If we travel inland from Cape Moreton on the same general bearing exhibited before, we shall find an almost equal slope from the high lands at the heads of the drainages to Moreton Bay as appears on the slope of the Blue Mountains towards Port Jackson; for in 1853 I made the elevation of the granite domes near Maryland, by barometrical observations, 3,727 feet, and the dividing range between the Condamine and Dumaresq Rivers, at the head of the latter, 3,120—Mount Melbourne being 3,829, and Moubullon, or Craig's Range, 3,640 feet—Mount Cordeaux, according to Cunningham, being 4,100 feet, which is very near the height of the land above the tunnel on Mount Clarence, which itself is 3,658 feet. The relations of land and sea appear then to be nearly exactly equivalent to those in the southern coast region of New South Wales, since, though there are higher points in New England and in Maneroo, than those already mentioned, yet the general elevations are much the same in both districts, and as off Moreton Bay there is a deep depression, so there is another off Mount Dromedary and Twofold Bay. What relation these depressions have to each other is not yet fully ascertained; but it is nearly certain that the bases of New Holland and New Zealand meet somewhere about half way between them, and the stages of ascent are precipitous or with long inclined slopes, the deepest depressions lying as it were on each side of a submarine plateau.

In my view, the combined phenomena as exhibited by the opposite coasts of these countries (which formerly extended further into the ocean)—by coral reefs and other conditions—induce the conclusion that great rents and denudation in the earliest periods of our geological history were the result of depression and submergence, affording channels for ocean currents, deep receptacles for cold stagnant water, and passages for such surface currents as that which bathes New South Wales with a stream warmed in latitudes nearer the Equator than that of Sydney or Brisbane. Much of the history of that stream has to be discovered, but the fact elicited respecting the submarine valley north-easterly from

Cape Moreton is an item in the account. I have thought it, therefore, worthy of especial notice.

If, for the sake of illustration, we could raise New Holland, New Zealand, New Caledonia, and New Guinea, to one uniform additional height of some 2,600 fathoms above the ocean, we would, I think, perceive similar features on the surface, so formed, to those which are now exposed, and be able to show what can now be only surmised, that the remark of Dr. Hooker before referred to is strictly true; and also, that in examining critically the present surface of the land, we can reproduce what the ancient surface was which is now buried beneath the waters. And from the examination of such portions of the ocean-bed as have been sounded, we may gain valuable hints in the endeavour to account for many of the superficial phenomena of the still exposed and denuded dry land.

In corroboration of this view of the subject, I will conclude with a quotation from a very important work of Mr. Alfred Russell Wallace, just published, "*On the Geographical Distribution of Animals, with a study of the relations of living and extinct Faunas, as elucidating the vast changes of the earth's surface.*"

"The well-known fact" (says that accomplished writer, vol. i, p. 35) "that nearly three-fourths of the surface of the earth is occupied by water, and but little more than one-fourth by land, is important as indicating the vast extent of the ocean by which many of the continents and islands are separated from each other. But there is another fact which greatly increases its importance, namely, that the mean height of the land is very small compared with the mean depth of the sea. It has been estimated by Humboldt that the mean height of all the land surface does not exceed a thousand feet, owing to the comparative narrowness of mountain ranges, and the great extent of alluvial plains and valleys; the ocean-bed on the contrary, is not only deeper than the tops of the highest mountains which rise above its surface, but these profound depths are broad sunken plains, while the shallows correspond to the mountain ranges, so that its mean depth is, as nearly as can be estimated, 12,000 feet."*

It being no part of the present subject to go further into the former connection of Australia with New Zealand, the remarks of Mr. Wallace, founded on the relationship established between certain portions of the Faunæ of those countries, as evidenced by those of the intermediate islands, have not been alluded to on this occasion, but he offers sound reasons for the belief formerly

* "This estimate has been made for me by Mr. Stanford, from the materials used in delineating the contours of the ocean bed on our general map. It embodies the results of all the soundings of the "*Challenger*," "*Tuscarora*," and other vessels, obtainable up to August, 1875." [The *Abstract* above given is, therefore, additional to those mentioned by Mr. Wallace.]

expressed by me that such a former connection is highly probable, notwithstanding the enormous depression now existing between New Zealand and Australia.

Mr. Wallace shows that even now the land on the face of the globe "is nearly continuous, and that it is possible to go from Cape Horn to Singapore and the Cape of Good Hope without ever being out of sight of land, and, owing to the intervention of the numerous islands of the Malay Archipelago, the journey might be continued under the same conditions as far as Melbourne and Hobart Town." (p. 37.)

SOME NOTES ON JUPITER DURING HIS OPPOSITION OF 1876.

BY G. D. HIRST.

[*Read before the Royal Society of N.S.W., 2 August, 1876.*]

I SUPPOSE that of all the members of our solar system, with the exception perhaps of our satellite, the Moon, there is no object that so soon engages the interest or more readily yields to the scrutiny of the amateur astronomer, when, with his newly-acquired telescope before him, he sets himself to investigate some of the wonders of the heavens of which he has been hitherto altogether heedless, or which at best have excited his idle curiosity as they have met his gaze, than the giant of our planet-neighbours, Jupiter; and the reason of this a slight inquiry will, I think, make obvious.

Mercury, as far as we at present know the closest of our Sun's attendants, is an almost hopeless object for even the possessor of the finest telescope. His minute size, and in consequence of his position his intense luminosity, prevent anything like details ever being seen. Moreover, when in his most favourable position for observation, which is when he is furthest from the Sun, we, from his orbit being interior to the Earth's, see but half his disk illuminated. Therefore, to these unfavourable circumstances we must attribute the title Mr. Webb has given him in his "Celestial Objects" of a neglected subject.

To Venus much the same arguments apply. Being larger than Mercury, and also nearer to the Earth, we certainly do see somewhat more of her; but her brilliance baffles all satisfactory definition, and I think no well-accredited markings or details of any sort have ever yet been accorded of this, to the eye most beautiful, but in the telescope most disappointing, planet.

Passing now to Mars, the first exterior planet to the Earth, we see what neither of the interior two can ever show us—a full round disk illuminated by the solar light; and we have the further advantage of our object being brought at favourable oppositions very near the Earth. Here we can see marks which no very great stretch of imagination or analogy may lead us to suppose as representing land and water, more especially as adequate optical means enable us to descry white spots at his

poles, which, by their diminishing during the Martial summer and increasing in his winter, convince us to be ice. Still, with the possessors of small telescopes, Mars is not I think a prime favourite. The period during which we can advantageously observe him is short—a few weeks before and after opposition; after which he rapidly recedes from us, and his orbit carries him so far off that his disk dwindles down to most uninteresting proportions, and his markings are lost to all small glasses. Besides, even at opposition it requires a really good and powerful telescope to do satisfactory work on Mars. In the best drawings that I have seen there is a strange haziness about details, and different observers appear to me to disagree most woefully in their delineations.

Saturn has for many I must confess, including myself, a large number of attractions. I cannot well dwell at present on the subject, as it is foreign to the object of this paper; and even a short account of his wondrous details would require a paper by itself. Still, confining myself to the premise that I am speaking almost exclusively of amateurs, and as such possessing only moderately powerful telescopes, Saturn, from his enormous distance, presents difficulties which Jupiter does not; his ring, with Ball's division, perhaps a belt, and three or four of his satellites, are as much as most small telescopes show; what has been discovered besides are details of great delicacy, and some points connected with Saturn remain tests for the largest and most perfect telescopes of the present day.

So there remain but Uranus and Neptune; and I wonder, out of all that have ever lived on the earth, how many have ever seen these at all. Indeed, a very few. They might, I fancy, be counted on your fingers; and, should an ordinary observer get one of these outside wanderers by accident into the field of his glass, he would probably pass them by as fixed stars.

We return therefore to the subject which brings me before you—Jupiter. How readily his noble disk shows out in even the smallest glass, many of you—and I suppose that there are few here who at some time or other have not seen him through a telescope—are well aware. An aperture of even a couple of inches will show some signs of streaks on his disk, and his moons quite brilliantly. As we increase our aperture and power, more and more detail comes into view, the belts assume definite form, traces of colour are seen, and his four satellites turn out very respectable-sized disks of their own. Their shadows, their occultations, and their eclipses present a scene of ever-varying interest and beauty; and this, with the extreme facility with which it can be seen in even what are now considered small telescopes, makes Jupiter, as I said before, a most interesting object for all amateur observers.

About the beginning of May the following circular from the Royal Astronomical Society, London, was handed to me :—

"Royal Astronomical Society,
Burlington House, London, W.,
March, 1876.

"The periodicity of changes in the colour and markings upon the planet Jupiter, and the connection that has been suggested between them and the solar phenomena, render it most desirable that a general system of observation of the planet should be organized. To this end, Dr. Lohse, in the year 1873, appealed to astronomers in the Northern hemisphere, and a response was made which has enabled him to collect and put on record many valuable descriptions and drawings of the planet's appearance since that time.

"The Royal Astronomical Society of London is deeply impressed with the importance of the question; and to assist in carrying out the plan of international observation suggested by Dr. Lohse, it has appointed us as a committee to endeavour to enlist the sympathies of observers generally, so as to obtain as extensive a series of observations as possible.

"The Southern declination of the planet will for a few years prevent satisfactory results being obtained in Europe, and we therefore desire to appeal to Southern observers to continue the work already begun.

"Drawings of the planet's appearance should be made as frequently as possible, giving in all cases the local or Greenwich meantime of the sketch, with particulars of the instrument and power employed, and the state of atmospheric definition.

"Careful notes of the tints and colours of the belts are most important.

"Particular attention is requested to the occurrence of the small bright spots, first observed by Mr. Lassell, and to the approximate Jovicentric latitudes in which these spots appear; also to small black spots which are occasionally seen in the equatorial zone.

"The phenomena presented by the satellites in transit, and their varying brightness considered with respect to their orbital position, are matters on which accurate observations are much desired.

"To ensure uniformity, we beg to send you some forms on which drawings can be made. These have a polar flattening of one-sixteenth. In all cases the north and south poles of the planet should be indicated in the drawing.

"All drawings and communications should be sent to 'The Secretary of the Jupiter Committee,' Royal Astronomical Society, Burlington House, London, W.

"Your obedient servants,
WILLIAM HUGGINS.
E. B. KNOBEL.
LINDSAY.
OSW. LOHSE.
A. C. RANYARD.
ROSSE.
F. TERBY.
T. W. WEBB."

Having at the time the use of a fine 10½-inch silvered glass reflector, the property of Mr. J. U. C. Colyer, who has for these and other observations kindly placed it at my disposal, I determined immediately on receipt of this circular, to commence and carry out, as far as lay in my power, a systematic course of observations, accompanying them by sketches made at the telescope, and the results up to the present are now before you. In making these

drawings I have been aided by a most efficient driving-clock, which keeping the object in the centre of the field of the telescope leaves both the hands free for other work, the advantage of which can only be appreciated by those who, in their attempts to delineate the heavenly bodies, are obliged to have one hand constantly employed in screwing away at a handle, to follow the motion of the object as it rapidly flits through the field.

The construction also of the Newtonian reflector is peculiarly adapted for drawing purposes, as the erect position of the observer is easy and natural; and with your desk at your elbow, you can rapidly transfer your eyes from the telescope to the paper before you.

On the whole I must say that the weather we have been favoured with since I commenced these observations has not been eminently adapted to telescope-work. We have had a rather more than fair allowance of cloudy evenings, and many of the most brilliant nights have been utterly worthless, from their blurred and tremulous definition; moreover, there appears to be at all times present a considerable amount of vapour in the higher regions of the atmosphere, so that even when definition is most steady, you have a consciousness that you are looking at the object under a veil, the field of the telescope not appearing perfectly dark as it should do. This is more especially tantalizing, as even on some of the most inferior nights you get moments—they only last for a second—of most startling definition, when the planet seems to be brought to within half its usual distance, and details start out before you so numerous, and so complex, that the eye in that evanescent moment totally fails to grasp them, and the next second they are gone, and you are left with a dazed impression that you have seen *something* that would tax the skill of a far more accomplished artist than yourself to do the slightest justice to. I have at times—but only, as I said before, for a second—seen the whole of the disk of Jupiter covered with fine lines; even the white belts, which ordinarily present not a trace of marking, are scored by them all over; and the darker equatorial zone appears a mass of flocculent, cloudy matter; but to attempt to put this on paper during the fleeting moment it is visible is an impossibility.

While on this part of my subject I may mention that one of the first things that attracted my attention, when looking up the observations recorded of Jupiter during the last ten or fifteen years, was the remarkable paucity, I might almost say the entire absence, of any reliable or well-executed drawing of the planet. I must, of course, confine this assertion to any published drawings for there may be, and probably are, many fine delineations in the hands of those who drew them, which will never see the light; but speaking of those pictures which have been given to

the scientific world through the medium of the papers of astronomical societies, periodicals, or books, I must confess it a matter of great surprise, that so few and such crude attempts have yet been made to give to the general astronomical reading public an idea of the telescopic appearance of this, the most magnificent of our planets; and the reason I am at a loss to see; for as I have before said, Jupiter is certainly, excepting our Moon, the easiest of all telescopic objects, and after a little practice, any one I am sure, with a decent notion of using his pencil or chalks, may give a far more accurate representation of the planet than he will find in the most elaborate and expensive astronomical work he can lay his hands on. Very few drawings ever represent colours at all; in a very extensively got up work I have in my library the belts are represented as straight lines—as if, to save trouble, they had been drawn with a ruler; in others there is an attempt at a ragged, cloudy appearance, but the artists who represented them evidently drew from what they had heard rather than from what they had seen. Messrs. De La Rue and Lassell have both furnished what have been said to be remarkably fine drawings, and probably the originals may be; but if this is the case a lithograph copy of one of them that I have seen must be a most woeful libel. Mr. Browning, of London, has one or two coloured representations of Jupiter; his most recent, I think, is that in the fifth volume of the "Student and Intellectual Observer." The volume is now before you, and I should be glad if any member present would tell me if it represents anything like what he has ever seen of the planet. In making these remarks, be it understood, I am not claiming for my own attempts any superiority; nobody can be more conscious than I am myself of their shortcomings, and much that I have seen has baffled all my endeavours to pourtray—as for instance, I have again and again, on favourable opportunities, seen a perfectly metallic appearance on some parts of the equatorial zone, which I cannot even describe, much less draw; so what I have said is not so much to depreciate what has already been done, but to express a surprise that more has not been done in this class of astronomical work, by those who have the skill, the time, and the instrumental means.

You will notice that the circular of the Royal Astronomical Society expresses that a connection has been supposed to exist between some of the phenomena observed on Jupiter and the maximum and minimum of the solar spots. From the evidence as yet adduced it cannot be said at present to amount to more than a supposition; still, as Mr. Russell very pertinently observed on the first meeting of our Astronomical Section, speaking on this subject—"We may not but believe that any disturbance affecting our ruler (the Sun), must pulsate through the whole retinue of

his dependents, bound together inseparably as they are by the law of gravitation."

Whether these influences, as in the case of Jupiter, make themselves manifest to us by what our telescopes show us to be going on on his disk cannot yet however be placed among astronomical facts. It is to obtain evidence on this point that they are so anxious in the Northern hemisphere that Southern observers should fill the gap which, in consequence of the great Southern declination of Jupiter, would otherwise exist in the records on which this theory is to be built.

Turning our attention now to the minute white spots mentioned in the circular, let us see what records we can find of their previous appearance, and what connection we can trace between their apparition and the maximum of the solar spots. I think we shall find there are some striking coincidences.

The first account that I can lay my hand on is one by Cassini, in the "Mémoires de l'Académie" for 1692, where there is a paper in which he notices great changes and bright spots on Jupiter. I find there was a sun-spot maximum for the year 1693.

There are some observations of Sir William Herschel of white spots and irregular bands in 1778, 1779, and 1780. He also observes what he calls a similar appearance in 1790. Two very considerable solar and magnetic maxima occurred—the one in 1779, and the other in 1789.

In the year 1848 the Rev. W. R. Dawes perceived some very remarkable white spots in Jupiter, which he likened to the circular craters on the Moon, and on the 27th March of the following year, Mr. Lassell saw them in his 20-feet equatorial reflector. Again, in May of the same year, Professor Schumacker, of Altona, observed four or five of these features on one of the belts, which he thus describes:—"They are white spots, and are all perfectly round, distinct, and bright. The largest of them is as distinct and well-defined as the disk of a satellite appears in a 9-feet reflector. They are striking phenomena, keeping their relative positions, as they are carried along by Jupiter's rotation, and there are no other similar spots on his disk." A sun-spot maximum occurred just at this time. De La Rue, in 1856, very near a sun-spot minimum, with 13 inches of aperture, makes a drawing showing no traces of white spots, and another drawing made at the same time by Piazzi Smyth, on Tenneriffe, agrees almost entirely with his. Lassell again, in 1859, approaching a spot maximum, figures the white markings, and says he "had failed to see these spots for many years, but latterly they had appeared again." In 1861, Sir W. Keith Murray contributed some drawings with a 9-inch refractor showing the spots, and other observers confirmed his observations with telescopes of 5 inches and upwards. At the same time the report of the

Greenwich Observatory states that, with the great equatorial, Jupiter presented appearances not previously recorded, and drawings made from that telescope by Mr. Carpenter coincided entirely with Sir W. Keith Murray's. The next maximum of 1871 I find comparatively bare of records; but there are accounts scattered here and there among the notices of the Royal Astronomical Society, of bright spots and patches observed on the equatorial belt; and if my own negative evidence goes for anything, I may state that during this year, which is just after a spot minimum, though I have attentively watched for these phenomena, I cannot record a single sign of them.

Testimony so far appears to point to a strong probability of the connection of these remarkable features with our eleven-year solar disturbances; but more is needed before we accept the theory as a fact. If the Earth were viewed from a distance, the auroras most prevalent about the maximum period might give a perceptible tint to parts, but they would be near the poles; there might be similar phenomena producing similar changes on Jupiter.

The small black spots mentioned in the circular appear to be a class of objects of somewhat more recent observation, and, so far as we can judge from the few observations recorded of them, they seem to coincide with the solar minimum of spots, as the bright spots do with the maximum. They are somewhat minute objects, and might be easily overlooked unless the observer possessed a good glass of large aperture, and an eye used to this particular work; but granting these conditions—and they become on favourable nights very conspicuous and remarkable phenomena—I have at times seen these spots so intensely black that I could scarcely persuade myself that they were not the shadows of satellites crossing the disk of the planet; but that this is not the truth becomes apparent if we watch them, for they retain their relative position with the other markings, and rotate with them, which of course the shadows of satellites do not do. It is difficult not to believe that these spots have a different nature from the well-known shadings and belts: they are so hard in their outline, and so very much blacker than any of the other markings. It has been I believe suggested that they may be the tops of mountains protruding through the cloudy envelope surrounding Jupiter; but, if this is the case, they must possess extraordinarily feeble powers of reflection, to appear so dark by contrast with their surroundings.

I have prepared a diagram on a large scale of the disk of Jupiter, which I hope my astronomical friends present will not laugh at. It is not intended to present the appearance represented by Jupiter at any one time, but rather as a map combining some of the more remarkable and persistent features I have

observed on his disk. I hope by its aid to make some of my remarks more intelligible, and have purposely exaggerated both colours and markings, in order that they may at a distance make themselves more readily seen. The black spots, you will observe, make their appearance principally on the darker bands; in fact, I have only recorded one occasion on which I noticed a black spot on the brighter portion of the planet, but that was a very remarkable one; it was quite as black as the shadow of No. 1 satellite, and was connected with the equatorial belt by a thin ligament. The next thing I would direct your attention to is the colour of the various portions of the disk; and here we open Pandora's box of trouble; for different eyes, different telescopes, and different states of our atmosphere, combine to give most conflicting statements. There is matter enough in this portion of my subject to form a treatise by itself, but time will not permit me to do more than give a brief statement of facts, and leave theorizing on the matter for some other occasion. I would, however, first give you a short account of what I have been able to find recorded of previous observations of the colours of Jupiter, in order that you may compare them with my own, as illustrated in the drawings before you.

Sir William Herschel, in "The Philosophical Transactions, 1794," says—"I viewed Jupiter with a 40-feet reflector. There are two very dark, broad belts, divided by an equatorial zone or space, the colour of which is of a yellow cast." To take more recent observations, I note that on 7th November, 1869, Mr. T. Elger, of Bedford, says—"I noticed the space between the central belts was peculiarly ruddy." Mr. Salter, of Manchester, says, on the same date—"The colour of the equatorial streak was rich tawny." Mr. Gledhill, F.R.S., same date, says—"Whenever the air was good the ruddy tinge of the equatorial belt was easily seen." A photograph of the planet taken in this year shows the equatorial belt absolutely transparent, the light from the ruddy belt having failed to act upon the sensitive plate; yet, speaking of this particular photograph, Mr. Browning says, he has seen photographs taken at other times when this belt exerted the most action. In the year 1871 Mr. John Browning devoted some attention to the planet, and his drawings show the equatorial belt to be of a bright yellow colour. Towards the end of 1871 there appears from various records to have been a general diminution in the intensity of the colours, and more especially in that of the equatorial belt, which had lost much of its yellowish hue. In 1872 Mr. Birmingham describes the equatorial belt as rose-coloured. In the same year Mr. Browning again draws the planet, and his views show a reddish yellow. The colour generally of the planet in this year, from various records, seems to have been particularly vivid, and Mr. Lassell appears especially struck with it. I will quote his

remarks, for perhaps some may think I may in my drawings have been inclined somewhat to exaggerate the colours—a fault I have most carefully tried to avoid. On the 2nd June, 1872, he says, using a 24-inch reflector—"I acknowledge that I have been hitherto inclined to think that there might be some exaggeration in the coloured views of the planet; but this property of the disk on the occasion I speak of was so unmistakable that my scepticism is at last beginning to yield. I have attempted in the accompanying drawing to represent the colours as faithfully as I can, and to convey something like a general notion of the distribution and intensity of the various lights and shades scattered over the planet, but to give anything like a faithful outline of the individual phenomena is far more than I can pretend to." These words of Lassell have come home forcibly to myself, again and again, when in moments of magnificent definition, such a wealth of detail has been presented to my sight that my pencil has lain idly by, and I have been content to gaze in almost open-mouthed wonder.

After 1872 the planet appears to have for some time shown no remarkable amount of colour—at least I have not been able to put my hand upon any observation in which the equatorial belt has been especially noticed as presenting anything particularly unusual in this respect. And Mr. Browning says, in June, 1873—"The colour of the equatorial belt of Jupiter was fading during the last weeks of the previous opposition; during the present opposition the colour has been scarcely, if at all, perceptible." In the same year Dr. Lohse, as you will have noticed in the circular, made an appeal to astronomers generally in the Northern hemisphere, that drawings should be systematically taken of the planet. One of the results of this request, and the only one that I am able to show you, was a series of drawings made by Dr. Copeland, using the great Lord Rosse telescope of 6-feet aperture. A lithographic reproduction of these is now on the table. I believe these drawings were thought a great deal of at the time, and they were specially mentioned at a meeting of the Royal Astronomical Society, as showing an immense amount of detail; but I may mention that I have repeatedly observed more detail in the 10½-inch reflector on an ordinary night than is shown in any one of them. You will observe moreover, that there is a reddish tinge in all of them, pervading the whole of the disk. This I cannot fancy really belongs to the planet, but is communicated by the metallic reflector; for it is a known fact that these old metallic reflectors gave all objects a ruddy hue, and it is believed that this explains the appearance of so many red stars in the elder Herschel's catalogue.

The most noticeable feature in these drawings of Lord Rosse is the great loss of colour sustained by the equatorial belt. This

belt, which in 1870 was so red that, according to a naked eye observation of Dr. Copeland in September of that year, the general colour of the planet's light was affected by it, shows in nearly all these illustrations very little (if any) colour at all.

In the year 1874 there appears to have been an increase of colour, for Mr. E. B. Knobel says—"The colours of Jupiter this year have been far more conspicuous than in 1873. A marked change in the tint of the equatorial zone has taken place. In May 1873 it was observed of a decided brick-red tint. On no occasion this year has that tint been remarked, but a bronze yellow or sienna has prevailed for the whole period of observation, though perhaps on one or two nights it approached more to a rich yellow."

After remaining at a minimum of colour for two or three years, Jupiter seems now to be regaining his tints; but in many cases I have noticed a marked difference between what I now observe and what has been previously recorded. On first directing the telescope to this planet, at the beginning of May last, I was immediately struck with the bright orange-yellow of the equatorial zone. This was most conspicuous with all powers from 50 to 500, and could still be traced with the aperture reduced to 4 inches—the colour was of course much affected by bad definition—when the air was unsteady it required almost the full aperture to show its existence, and the reduction then required to give a clear perception of the dark streaks would render it almost invisible; but on a steady night, when a magnifying power of (say) 200 could be used with the full aperture, the equatorial zone has appeared almost invariably, with one or two exceptions which I shall mention by-and-by, of a rich orange. Shortly after I commenced the present series of drawings, I had occasion to show some of them to Mr. H. C. Russell, of the Observatory, who was himself engaged in similar observations. The first thing he said when he saw them was—"Why, you don't use the same colours that I do at all." A short time subsequently I went to the Observatory for the sake of comparing the telescopes, and to my utter surprise the equatorial belt that I had invariably observed with the reflector to be a tawny orange or yellow appeared in the 11½-inch refractor of a bright rose-pink. That this was no sudden change in the planet has since been amply confirmed, for Mr. Russell's drawings and my own on the same nights show each the different colour. Moreover, I have on other occasions compared the glasses, and the same distinction still exists: the reflector continues to show the equatorial belt yellow, and the refractor pink. The same pinkish tint has been observed by me, though in a less degree, on account of the smaller aperture, in a fine 4¼-inch refractor, the property of Mr. Alfred Fairfax, of Double Bay. Mr. Russell has recently erected an 11-inch silvered glass reflector of his own manufacture at the Observatory, and he confirms my

opinion as to the tawny yellow of the equatorial zone, as seen in that description of telescope.

Now I must confess I am at present totally at a loss for a theory to account for these contradictions. The refractor showing, as the best object-glasses do, a fringe of uncorrected purple or violet light round a bright object such as Jupiter, ought according to theory, to give the planet if anything a yellow tint, that being the complementary colour; but this is exactly what it does not do. The refractor, on the contrary, ought to give a reddish cast, as the reflection from silver is slightly tinged with that hue; but this is just the colour that *it* refuses to show. There is some unexplained mystery here, which I cannot now stay to inquire into, but content myself with putting just the bare facts before you.

The great equatorial belt of Jupiter appears at times to be the seat of sudden and violent disturbances, taking place on a scale of which we can scarcely form any conception. I have seen the whole appearance of this belt alter during the interval of from one night to another, so that though the same portion of the disk was presented to the eye, not a single feature in this part of the planet could be recognized in the drawing of the previous night. One notable example of this occurred on the 24th May. The equatorial belt had presented a particularly quiescent appearance for some time before, occupying not more than a third or a fourth of Jupiter's diameter. On the evening of the 24th of that month I noticed that it had suddenly spread over fully one-half of the disk, and seemed to be the seat of the wildest commotion, being torn and twisted in the strangest manner. Curious to say, this only applied to one side of the planet, for the opposite side preserved the calm appearance before referred to, the equatorial zone being exceedingly narrow. This outbreak lasted for some two weeks, and then gradually appeared to calm down. On the 23rd June there was another similar outbreak, accompanied as before by another extension of the equatorial belt, and also—and this is why I particularly mention it in this part of my notes—by an almost total loss of the yellow colour so remarkably predominant before in this part of the planet. This loss of colour seems to arise from the spreading over the yellow belt of the dark-gray or chocolate-coloured bands with which it is usually streaked; during these out-breaks they appear to extend as it were laterally, and to colour almost completely the yellow, which is only then seen between them in thin streaks. A strange feature noticed by me on the 4th July was that one of these dusky bands was bordered by a narrow edge of crimson lake; it could not have been more than a second or two of arc in diameter, but was most vivid; and it gave me almost the impression as if I were looking at a scarlet or crimson flame.

The polar portions of Jupiter, to which I will next direct your

attention, do not present the same ever-varying character of the equatorial belt; the causes which produce such tremendous disturbances at the equator do not appear to affect in anything like the same degree the northern and southern latitudes. You will observe in the large diagram, that I have coloured the north pole a decidedly brownish green, and this is the almost uniform tint that it has presented to me. On evenings of bad definition the green is scarcely visible; but when the air is sufficiently steady it is most conspicuous, and is a very beautiful feature: it requires a certain amount of magnifying power and considerable aperture to bring it out well; it is scarcely apparent with anything under 100, and a power of not less than 200 is by far the best, if the air will bear it. The reflector seems to possess a decided advantage over the refractor in showing the green tint; in the large Observatory achromatic it appears to me more of a smoky brown. The only record I can find of a green tint being observed at the poles is one in the "Transactions of the Royal Astronomical Society," by Miss Hirst, a lady residing in Auckland, who observed Jupiter during his opposition in 1875 with an 8½-inch reflector. She says—"On February 20th I noticed a small oval patch of a decided sea-green at the south pole, which on the following morning was more elongated and a shade darker in the centre. It remained thus for three days, and has not since been seen." The south pole has on all occasions been tinted with a warm gray. The most remarkable feature on this portion of the planet has been the persistent appearance of a cloudy mottling, which I have attempted to represent in the diagram. This was first noticed on the 3rd May, and it has continued to appear at intervals up to the present date.

Of the markings generally on the planet there are one or two which I will mention as being particularly characteristic and persistent. The strangest-looking of them is the one Mr. Russell and myself called the "Fish," on account of its presenting something of that form. It first made its appearance during the great outbreak about the 24th May; and it existed, though somewhat altered in shape, until the 4th July; there were always one or two black spots on the southern edge of it. The next peculiar marking was one I called the "Tuning-fork." I have represented it here on the diagram. On the north rim of the equatorial belt there appeared from the beginning of May to the middle of June a succession of remarkable breaks, the dark band on the following side being as it were cut short off, and on the preceding side it is thrown suddenly up, and extends right across the disk in a thin streak.

We have been accustomed to talk of the belts and clouds of Jupiter as if they were in their nature somewhat analogous to the clouds of watery vapour in our own atmosphere, or as perhaps

exhalations from molten matter constituting the body of the planet. But there is sometimes a strange persistency in these features, which seems incompatible with a vaporous nature only; and I think that those who have had the best opportunities for observation in this particular subject will be the last to hazard an opinion as to their origin. Unfortunately, too, the spectroscope fails to help us here: for Jupiter, shining as he does by reflected light, gives back the solar spectrum, with the addition of a few lines somewhat similar to those added when the sun is low down, and, consequently, shining through a considerable extent of our atmosphere. The spectrum, too, of Jupiter is, contrary to what many would suppose, exceedingly faint, being only about equal to that of a third magnitude star; the brilliant aspect that he presents to the eye being occasioned by the immense size of his disk, and not by its intrinsic luminosity. When I say that Jupiter shines only by reflected light I am aware that amongst some eminent authorities it is believed that he does emit somewhat more light than he receives; and Proctor, writing on this subject, says—"If Jupiter does not shine somewhat by native light, his surface must possess reflective powers nearly equal to white paper, which is scarcely credible." But this excess of brilliance, if it does exist, is too small to make any difference in the spectrum.

I feel the limits that I can fairly allow myself for occupying your attention will not permit of my entering into half of the many features which this interesting planet has presented during the present opposition, and of which I am persuaded much is new, and has in consequence never been recorded before. I will not, therefore, dwell now on the phenomena connected with the satellites, their transits, their shadows, and many other details of which more than enough remain for another discussion. Still less would I detain you by any attempt of my own to theorize on these wonderful and complex operations taking place on such a mighty scale—a scale of which the inhabitants of our little globe, 8,000 miles in diameter, can form no adequate idea. What, for instance, should we think if we saw, supposing that we could see, a black mass of vapour, or it may be of some far more solid substance, 22,000 miles in extent, suddenly break up and disappear in the course of a few minutes; and yet this very phenomenon was recorded by Sir James South to have taken place on one occasion when he was observing Jupiter.

There is, however, one theory of Proctor's in reference to the condition of Jupiter as affecting his colour which I will mention, as it seems to me to be one of the most reasonable yet broached, and moreover appears to accord well with observation. He thinks at a first view that nothing could appear more surprising than a change affecting the colour of a zone-shaped region whose surface is many times greater than the surface of our earth.

A brief change might be readily explained as due to such causes as affect our own air. Large regions of the Earth are at one time cloud-covered, and at another time free from clouds; such regions seen from Venus or Mercury would at one time appear white, and at another would show whatever colour the actual surface of the ground might possess when viewed as a whole. But it seems altogether impossible to explain in this way a change or series of changes occupying many years, as in the case of the colour changes of Jupiter's belt. It is one of the strongest arguments against the theory that solar action has to do with these changes, that any changes produced by solar influence would be so slight as to be in effect scarcely perceptible. If, however, Jupiter's whole mass be in a state of intense heat, we can understand any changes, however amazing; we can see that enormous quantities of vapour must be continually generated in the lower regions, to be condensed in the upper; and although we may not be able to indicate the precise reason why at one time the mid-zone or any other belt on Jupiter's surface should exhibit the whiteness which would seem to indicate the presence of clouds, and at another should show a colouring which appears to indicate that the glowing mass below is partly disclosed, we remember that the difficulty corresponds in character to that which is presented by the phenomena of solar spots. The most probable hypothesis appears to be that the ruddy glow of Jupiter's equatorial belt is due to the inherent light of glowing matter underneath his deep and cloud-ladenatmosphere.

This seems, as I said before, to be about the best theory yet advanced in this matter; but the human mind craves for something more substantial than mere supposition. And the questions that naturally arise when concluding a series of observations like the present are—Shall we ever in our present state *know* any more of the real nature and purpose of these magnificent orbs; shall this opposition of 1876 ever furnish a link in the chain that is to lift the veil that hangs on all outside; or are we but accumulating a pile of facts, a mass of observations, which, like the scattered necklace-beads, want the connecting string to form them into one harmonious whole? Are we, like the benighted wanderer in the desert, travelling in a circle, to find ourselves back at the point whence we started? Is it ever with the telescope and spectroscope to be "thus far and no farther"?

No! I cannot but believe that the time will come, though it be generations hence, when the fruit of many years of patient watching shall be,—the reversal of the complex pattern on the under side of which we have so long toiled, tracing with anxious care its numberless perplexing threads, and then the design of the Creator in the solar system will stand revealed in all its symmetry and beauty.

DISCUSSION.

MR. H. C. RUSSELL said, that Mr. Hirst had done a valuable work in watching so closely the changes which had taken place in the planet Jupiter during the present winter. A great many curious things had appeared.

Mr. Hirst had tried to collect the observations made upon the white spots, and to show that they had some connexion with the periods of the maximum sun-spots. If such a connexion could be shown satisfactorily, it would have much interest; but in 1863 he (Mr. Russell) saw the white spots on Jupiter most distinctly. He had never seen them so well since, and 1860 was the maximum sun-spot period before 1870.

The black spots were similar in form to the white spots. A theory had been hazarded that perhaps they were cyclones opening up the cloud envelope which is supposed to reflect the sun's light to us. If so, the persistence they maintain in their relative distances is very curious. He (Mr. Russell) had not been able to detect any difference in their position for a considerable time. Jupiter is 1,300 or 1,400 times the size of the earth, yet his revolution only takes 10 hours. If these cloud accumulations are produced by the revolution of the planet, the velocity of the currents must, therefore, be something enormous. Some of the markings on the planet Jupiter have been seen to recur years after, and we cannot conceive of any peculiar cloud-form recurring after a number of years. It seems probable that something solid has been seen on these occasions. We cannot expect cloud-forms to have that definite character and to retain it. His own opinion was that the great changes which had occurred within short intervals were simply changes in the state of definition, not changes on the planet, but changes in our power to see it. He had lost sight of certain features one night, and seen them another night.

In June, when we had a great change in the state of our atmosphere, the colour of the planet was altered. He thought the colour of the planet depended on the state of the air over our heads. The colours of the stars depend on something very mysterious. Being struck with the differences of colour observed through different telescopes, he had put a graduated scale of colours, varying from green to red, through yellow and orange. Through the telescope there came to view a definite point at which the yellow changed to pink—a point not visible to the naked eye at all. With a silver-glass reflecting telescope he observed the same phenomenon. He could only explain this by supposing that the pink had been put over the yellow.

MR. HIRST said that, as to the sudden disappearance of some of the markings, the remark of Mr. Russell was hardly borne out by some existing observations. Sir James South mentioned that a black patch on Jupiter, representing a space on the planet 22,000 miles in diameter, totally disappeared in the course of a few minutes. Such a conspicuous marking could scarcely be blotted out in a moment by bad definition.

Part I.

ON THE GENUS CTENODUS,

A FISH FOUND IN THE TRUE COAL MEASURES OF GREAT BRITAIN.

By W. J. Barkas, M.R.C.S.E., L.R.C.P.L.

[*Read before the Royal Society of N.S.W.*, 6 *September*, 1876.]

Knowing that very few persons are acquainted with the fossil ichthyology of the Carboniferous formations of Great Britain, even in Great Britain itself, it is perhaps necessary that I should state at once my reasons for introducing a paper before this Society upon a subject that is apparently foreign to this Colony and to all Australasia, for undoubtedly *Ctenodus* is not found anywhere in this part of the world. *Ctenodus* is a fish that existed during the Carboniferous era of Great Britain's history in comparatively large numbers, but inhabiting, so far as our present knowledge extends, only a very small area of its waters. Fishes of the same genus, but of different species, are found in the Old Red Sandstone, but they are very rare, and are even more limited in their habitat than the Carboniferous *Ctenodi*, judging, of course, from the scarcity of their remains that have been brought to light by geological research during a goodly number of years. Prior to the Devonian period we have not any trace of this fish, nor have any remains been discovered in formations that have been formed since the Carboniferous epoch; it was, therefore, considered to be a form of animal life that had become totally extinct at the close of the Coal Measure era, not having any counterpart in the different stages of the world's formation after that time. Although there was not, at the time of the first discovery of the remains of this fish, any known living type by which its place in the order of Being could be verified, the great palæontologist Agassiz at once classified it among the Fishes, for all that he had only been able to examine a few dental plates. Since the time of the discovery of the dental plates seen by Agassiz, extensive researches have been made into the Natural History of the World as it exists at present, and among these inquiries were some that were directed to the ichthyology of Australian seas and rivers. It was not long before the Hon. Wm. Forster obtained a fish from some

Australian river that was markedly different from all other known existing species,* and this fish was named *Ceratodus Forsteri* by Mr. Krefft, late Curator of the Sydney Museum, and I understand that he published an account of it in the Second Part of the Proceedings of the Zoological Society for 1870, but I have not had the opportunity of seeing the paper. Dr. A. Günther was the first, I believe, to give a full description of *Ceratodus;* this he did in the Transactions of the Philosophical Society for 1871. It was at once seen by palæontologists and ichthyologists that the detached dental plates called *Ctenodus* by Agassiz closely resembled those of *Ceratodus* in their configuration, and they drew the inference that *Ceratodus* and *Ctenodus* probably belong to the same family. Further researches into the Coal Measure shales brought to light other remains of the fossil fish, and these mineralized portions of the endo- and exo-skeletons were also seen to resemble closely similar parts of the recent fish. The fact, therefore, that *Ctenodus* is evidently the prototype of a fish found only in Australian waters at the present day is my apology for introducing this paper; which fact is rendered all the more worthy of attention when we think of the immense æons of ages that must have passed away since the Carboniferous period, during which time we have no trace of either *Ctenodus* or *Ceratodus*, nor of any allied form.

Ceratodus is, I suppose, tolerably well known to most of the ichthyologists of Australia, I shall therefore refer to it comparatively seldom, my principal object being to describe what is known of *Ctenodus*, and incidentally only will I point out the resemblances between those fishes.

Concerning the remains of *Ctenodus*, I am well able to speak; for Mr. T. Atthey, Mr. T. P. Barkas, F.G.S., and myself, have probably the most complete collections of them in the world, in fact, I know of no other Coal Measure palæontologists nor any Museum that have any other remains than the teeth, unless they have obtained them from the two first-mentioned gentlemen. I brought out specimens of the remains with me from England, but unfortunately some of them have been irreparably injured by the severe knocking about my boxes received while being carried from Sydney to Bombala, my present residence. Sir Philip de Grey Egerton obtained numerous specimens from my father, Mr. T. P. Barkas, which he intended for our Sydney Museum, but on inquiry I find that they have not been received, from some cause or other.

Ctenodus was so named by Professor Agassiz from some dental plates discovered in the Old Red Sandstone and Coal Measures;

* Since this paper was written I have been informed that the Rev. W. B. Clarke and Mr. A. W. Scott were the first to discover this fish's close resemblance to Agassiz's extinct genus, at least so far as the teeth are concerned.

he classified it among the Fishes as a Placoid; but, beyond naming the genus and species, he did little more; what remarks he makes will be found in his "Poissons Fossiles" tome iii. The species he founded were *C. alatus* and *C. asteriscus* from the Devonian formation, and *C. cristatus*, *C. Murchisoni*, *C. Robertsoni*, from the Carboniferous. Professor Owen falls into the same error with regard to the classification of this fish. That Agassiz and Owen should have erred in thus classifying *Ctenodus* is not to be wondered at, for they were only acquainted with the dental plates, and had no other fish presenting teeth of this type to refer to; any ichthyologist having only the teeth before him would make the same mistake, for they are unmistakeably *Cestraciont* in character. Hugh Miller, while examining *Dipterus*, another Devonian fish, discovered that it possessed teeth similar to those of *Ctenodus*; this discovery tended to show that Agassiz and Owen were mistaken in considering *Ctenodus* to be a *Placoid*, as *Dipterus* is, without doubt, either a member of the *Ganoidei* or the *Dipnoi*; the majority of palæontologists at present placing it as a *Ganoid*. Other fish remains were obtained, and named *Ceratodus* and *Tristychopterus*, with similar teeth. These four fossil genera, *Dipterus*, *Tristychopterus*, *Ceratodus*, and *Ctenodus*, were arranged by Professor Huxley, in his synopsis of the Ganoidei, in a family, which was named, *Ctenododipterini* by Professor Pander, having the following characters:—Two dorsal fins placed far back; acutely lobate pectoral and ventral fins; no branchiostegal rays; jugular plates; single anal fin; caudal extremity tapering to a point; lower lobe of tail much larger than upper; scales cycloidal and smooth; bones of cranium anchylosed into a shield; lower law of peculiar form; dentition ctenodont. Eichwald, in the first volume of his "Lethæa Rossica" further adds that *Ctenodipterines* have solid and distinct bodies in their vertebræ, and that their scales are rounded and imbricated besides being cycloidal. Dr. A. Günther, in his paper to which I have already referred, seems clearly to prove that *Ceratodus* belongs to the *Dipnoi*; if this be so, then *Ctenodus* must also do so, for these two fishes in their internal skeleton are similar in every respect so far as we know as yet; the complete tail of *Ctenodus* has not been discovered up to the present time, it may possibly differ from that of *Ceratodus*, but seeing that the fishes agree so far as their bony remains are concerned, it is not probable. However, while there is this uncertainty we will not dogmatize upon the matter, but will leave it an open question to be decided by future discoveries; still, it may safely be predicated that *Ctenodus* is related to whatever family *Ceratodus* may belong. From a private letter that I received in May last I learn that Professor Huxley has been lecturing during the past winter upon the relationship between *Ceratodus* and *Dipterus*, but, strange to say, he never spoke of *Ctenodus*, which is even more closely allied to *Ceratodus*.

The teeth are the parts of the fish *Ctenodus* that are most frequently discovered, and they have been obtained in places where no other remains of the endo- or exo-skeleton have been observed; they are most common in the true Coal Measures of Northumberland; occasional teeth are disinterred from the coal formations of South Yorkshire and Staffordshire; a single tooth has been obtained from the carboniferous limestone of Derbyshire; and there is a single specimen in the British Museum that is believed to have been found in the Coal Measures of Carluke, in Scotland; if the latter be a fact, then Carluke is the outermost limit of this fish's geographical range to the north, and Derbyshire is known to be the southern boundary; but even within this confined area the strata containing the remains are very small in extent; for example, Northumberland is the most prolific in its supply, yet nearly all the specimens are obtained from a pit at Newsham, the remainder being found at Cramlington; the same thing is observed in Staffordshire. Besides the narrow range of this fish, we can also judge that its habitat was in the shallow brackish waters of estuaries, and the mixed waters of the sea near the mouths of rivers; for we find its remains fossilized in the shales, in which are also imbedded numerous *Cestracionts* and *Ganoids* that certainly did not exist in fresh water, although they frequently roamed into the deep seas; such are *Cladodus*, *Psammodus*, *Palæoniscus*, *Rhizodus*, &c. To this fact there appears to be an exception. I refer to the tooth found in the Derbyshire limestone, that seems to prove that *Ctenodus* was also a deep-sea fish, but a little thought will show its improbability; only one tooth has been obtained from that stratum, notwithstanding the extensive researches that have been made into it; the tooth has, therefore, been most probably carried out into the deep sea by a strong under-current, or a solitary fish may have strayed out and died from inability to exist in a foreign water, leaving its remains to decay or become imbedded in the forming limestone. That *Ctenodus* did not live in fresh water is clearly proved by the fact that the shale containing these teeth has never been observed, by me at least, to contain fossilized terrestrial or fresh-water vegetation. So much for the classification, geographical range, and habitat of *Ctenodus*. We will now turn to the fish itself, and in this paper I shall confine myself to the teeth, describing the characters of the different species and illustrating them by drawings. In future papers I shall pourtray their microscopical structure, draw attention to the characters of the bones that enter into the formation of the mouth and the mode of arrangement of the teeth, and finish by describing the endo- and exo-skeleton.

C. cristatus was the first species named by Agassiz, and was founded upon a tooth at present in the Leeds Museum; Mr.

T. P. Barkas, and, I believe, Mr. Atthey also possess perfect specimens in their cabinets. The tooth was imperfectly described by Professor Agassiz in his "Poissons Fossiles," but tolerably figured.. Professor Owen referred to the genus in his "Odontopography" among the *Cestracionts;* and, if I mistake not, for I have not the book at hand for reference, the tooth he figures, and figures well, is one of *C. cristatus*; but his remarks on the external characters are too brief to be called a description, while his sketch of the minute structure is quite inaccurate. Messrs. Hancock and Atthey, in a paper entitled "Notes on various species of Ctenodus obtained from the Northumberland Coal Fields," which appeared in the third volume of the "Transactions of the Northumberland and Durham Natural History Society," were the first palæontologists to give a complete description, and it may be summed up as follows:—Tooth plate-like; rather thin; irregularly elliptical; inclining to ovate; 2¼ inches long, 1¼ inch broad (these measurements are, of course, average); the upper surface somewhat hollowed or concave; inner margin well arched, the outer much less so; upper surface is covered with twelve close-set transverse ridges, which are studded from end to end with closely arranged tubercles; ridges increase in size externally and incline towards the anterior and posterior margins, thus appearing to radiate; grooves angulated; tubercles perfect only on outer margin and are covered with brilliant enamel; base of each tubercle subtriangular; the imperfect tubercles are much worn and compressed laterally; tubercles and ridges coarsely and irregularly granular. Mr. T. P. Barkas, F.G.S., briefly describes his specimen, in a paper on "Ctenodus," which appeared in the "Geological Magazine" for July, 1869.

C. Robertsoni is only referred to by Agassiz himself in the "Poissons Fossiles"; he neither describes its external character nor does he figure them; but he refers slightly to its microscopical characters, and attempted to pourtray them; the description and engraving are, however, nearly valueless from the meagreness of the one and the low power of the microscope that has been employed in examining the other.

C. Murchisoni was named by Agassiz, but neither described nor figured by him; and Pictet merely gives the name and founder of the species in the second volume of his "Traité de Palæontologie."

C. alatus, from the Old Red Sandstone, is merely mentioned by name by its first observer, Agassiz, in his "Poissons Fossiles."

C. asteriscus (Agassiz), also from the Old Red Sandstone, is just hinted at by name by Giebel in his "Fauna der Vorwelt."

The four last-mentioned species may or may not be true species for anything I know to the contrary; and I am not aware that any palæontologist who is acquainted with the recent discoveries

of the teeth of different species of *Ctenodus* has ever seen them; and, as I have said, neither descriptions nor figures are extant for comparison.

C. tuberculatus was discovered by Mr. T. Atthey, in the shale of the Low Main coal seam in Northumberland, and was so named by him. The discoverer, in conjunction with the late Mr. Albany Hancock, F.L.S., describe its teeth fully in the "Notes" that I have already referred to. The following is a brief epitome of the external characters of the tooth; plate-like; thick; irregularly ovate; 2¼ inches long; 1⅛ inch broad, but they vary a little in size, the specimen I figure is 2½ inches long and 1⅜ broad; narrow posteriorly; inner margin gibbous or angulated in the centre; outer margin a little convex; upper surface slightly convex, with from twelve to eighteen ridges traversing it, deep, sharp, parallel and approximate, strongly tuberculated towards the outer margin; grooves narrow, deep, and angular; ridges arched posteriorly and enlarged towards the external border, but they are not radiate; anterior ridge widest, and is reflected and prolonged somewhat beyond outer margin; tubercles conical with obtuse points, those near the outer border are coated with brilliant enamel and are well-produced; mandibular tooth narrower than palatal and very convex. From this description it will be seen that this tooth differs from *C. cristatus* in being convex, and in having sharp and deep ridges, and by the form of the tubercles. Messrs. Hancock and Atthey gave an illustration of this tooth in the fourth volume of the "Transactions of the Northumberland and Durham Natural History Society," but Mr. Barkas figured it previously in the sixth volume of the "Geological Magazine," and at the same time a drawing was given of a tooth in the British Museum, with a few remarks by the editor. Mr. Barkas also gives excellent lithographs in the "Atlas" to his "Coal Measure Palæontology." Mr. Miall of Leeds gave it as his opinion, in the Annals of Natural History, fourth series, volume 15, that there is not any difference between the teeth of *C. tuberculatus* and *C. cristatus*. I cannot help thinking that that gentleman has never seen a true tooth of the former fish or he would never have uttered this opinion, for they undoubtedly differ very much, but it is possible that they might belong to the one species, the one tooth being mandibular and the other palatal, but this is not probable, as *C. tuberculatus* is comparatively common while *C. cristatus* is very rare; nor have they ever been found on the same slab of shale; groups of the teeth of *C. tuberculatus* have been discovered which tend to show that the mandibular and palatal teeth are similar, the latter differing from the former in being narrower only; we must, therefore, for the present at least, consider these two varieties of teeth as belonging to different species. Fig. I. is a specimen of a tooth of

C. tuberculatus from the cabinet of Mr. T. P. Barkas. Alter the convexity to a concavity and shorten the external ridge to a uniformity with the others, and we would have an almost perfect figure of *C. cristatus.*

C. obliquus, Atthey. From the Northumberland Coal Measures, is a comparatively common species. It has been described and figured by Messrs. Hancock and Atthey in the third and fourth volumes of the "Transactions" I have already alluded to, and by Mr. Barkas in "Coal Measure Palæontology." Externally the tooth is plate-like; depressed; lanceolate; 1½ inch long; ⅝ inch broad; inner margin regularly and much arched; outer border slightly curved; six or seven strong, compressed, sharp-edged, transverse ridges, radiating somewhat towards the external margin, where being enlarged they curve downwards and are denticulated; anterior ridge very oblique, being much inclined forwards; tubercles much compressed laterally, lancet-formed with sharp points, coated with brilliant enamel; mandibular tooth narrower than palatal, is broadest in front, tapering pretty regularly posteriorly, anterior ridges very wide and much produced beyond the others, all the ridges are curved downwards, and vary from ⅜ of an inch to 1½ inch in length. In figure II. I have pourtrayed this tooth.

C. elegans, Atthey, is the commonest species found in the Northumberland carboniferous shales, and it is also the smallest variety. It was described in the "Notes" of Messrs. Hancock and Atthey, but was not figured. Mr. Barkas illustrates it in his work, and I herewith give a drawing of a very large specimen, Fig. III. The tooth is plate-like, depressed, triangular, averaging ⅜ of an inch in length and $\frac{3}{16}$ of an inch in breadth; inner margin produced and angulated in centre, from whence it slopes anteriorly and posteriorly towards the outer margin, which is slightly arched; seven to eight strongly denticulated ridges which radiate from the angle, at which point they are very minute; anterior ridge a little produced; six or seven denticles on each ridge, which are much compressed laterally, sharp-pointed and lancet-like, with inner limb a little shouldered, where there is occasionally a minute toothlet; ridges and denticles brilliantly enamelled. Professor Owen, in his booklet on the "Dental Characters of Carboniferous Fishes and Batrachians," founds a new genus, *Sagenodus*, upon some sections he had sent to him, but he never saw the original teeth; the structure exhibited by the microscope of these sections presented features quite new to him, and he accordingly designated the tooth *Sagenodus inequalis*. In this work he gave excellent illustrations of the structure, and it is similar in every detail to the microscopical appearance of *C. elegans*, which had been described fully long previously.

C. corrugatus, Atthey, was discovered in the coal shales of Northumberland. It was described by Messrs. Hancock and Atthey in their "Notes," but it has never been figured. Its characters are as follows (it must be remembered that my descriptions of the teeth discovered and named by Mr. Atthey are summaries of his remarks. I may state, however, that I possess or have examined specimens of each of his species): plate-like; thin; sub-triangular; three inches long, two inches broad; upper surface slightly convex, with nine stout, somewhat irregular rounded ridges; grooves wide and rounded; ridges die out as they approach the internal and external margins, but they are slightly enlarged at the external extremities, and are indistinctly and irregularly tuberculated; inner margin nearly straight; outer border slightly convex; anterior edge slopes forward from inner margin; posterior border produced and rounded; surface strongly and irregularly punctated. The distinguishing features of this tooth are the fewness of the ridges, their roundness and wide separation, its great size and general form.

C. octodorsalis, T. P. Barkas. From the Northumberland coal seams, was described in the second volume of "Scientific Opinion," but it was not illustrated. Its characters, according to Mr. Barkas, are:—length, two inches; width, one inch; eight ridges free from denticulations; at the extremities of the first six ridges there are slight depressions which indicate two rudimentary tubercles; the seventh ridge is drawn to a point, and the end of the eighth ridge is flat and chisel-shaped; the grooves between the ridges are broad, and their bases are shallow and smoothly rounded.

C. concavus, T. P. Barkas, is only founded provisionally, for its founder has occasion to think that it may be an unusual form of *C. tuberculatus*. It was discovered in the Coal Measures of Northumberland. The tooth is 2¾ inches long, 1¼ inch broad, very concave from without inwards, and presents the appearance of a large segment of a cylinder; the external edge is nearly straight; the internal margin resembles the side of an ellipse; the ridges are eleven in number, and extend across the body of the tooth at right angles with the front; the ridges are deep, angulated, and slightly curved; the anterior ridges are broad, and the remainder gradually narrow towards the posterior extremity of the tooth; except at the external extremities of the ridges, they are free from tuberculations; the crest of the anterior ridge is very convex, the others very concave; anterior ridge has two well-developed and two rudimentary tubercles; the second three well-defined; third, fourth, fifth, sixth, seventh, have one each; the eight has two, and the remaining ridge one; each external tubercle on first, second, and eighth ridges are covered by brilliant cream-coloured enamel; the rest are dark, and highly

polished; between the ridges and the plate of attachment there is a distinct line of pale enamel surrounding the tooth; the plate of the tooth is thin; under surface as convex as upper is concave. A description of the tooth appeared in the second volume of "Scientific Opinion," and an illustration was given in "Coal Measure Palæontology." In my opinion this tooth more closely resembles *C. cristatus* than *C. tuberculatus*. Fig. IV. is a copy of Mr. Barkas's lithograph.

C. monocerus, T. P. Barkas. From the Northumberland Coal Measures. It was described and figured in the paper and book just referred to. The tooth is 2½ inches long; 1¼ inch broad; five bold radiating ridges; first ridge projecting forward at an angle of 30 degrees, second at 45 degrees, third at 60 degrees, fourth at right angles to the base, fifth inclined backwards from the perpendicular 15 degrees; ridges smooth; tip of first ridge lost; second, third, and fourth ridges have each two highly enamelled tubercles at their extremities; fifth ridge one tubercle; the plate extends beyond the 5th ridge with an undulating surface for half an inch, and is symmetrically rounded off; upon the front of the tooth and opposite the groove of the fifth ridge is a large mammillary tubercle or horn which distinguishes this tooth from any other species. Fig. V. is a copy of the published drawing.

The teeth I have described so far have all ridges that are more or less tuberculated; those I now intend to refer to are without tubercles, and therefore more closely resemble the teeth of *Ceratodus*.

C. imbricatus, Atthey. From the Northumberland Coal Shales, was described in the 3rd, and figured in the 4th volumes of the Northumberland and Durham Natural History Society Transactions, by Messrs. Hancock and Atthey. The palatal tooth is depressed; very thick; slightly concave; 2¼ inches long; upwards of 1 inch broad; inner margin well and regularly arched, the anterior slope being much longer than the posterior: outer margin nearly straight and coarsely serrated by the ridges projecting; 6 ridges, which enlarge rapidly towards the outer margin, strong, smooth, somewhat distant from each other, and though mostly inclined forwards, are laid over towards the posterior end, having an imbricated appearance; grooves angulated, surface minutely granular, edges enamelled. Mandibular tooth very narrow and fusiform; ridges not imbricated and grooves scarcely angulated. Fig. VI. is a copy of Mr. Atthey's engraving. As my specimens are in England I cannot make an original sketch.

C. ellipticus, Atthey. From the Northumberland Coal Measures, was described in Messrs. Hancock and Atthey's "Notes." Palatal tooth flattened; thin; elliptical; 1⅝ inch long; ¾ of an inch broad; inner and outer margins irregularly arched; 5 transverse, smooth, distant, angular ridges, increasing in size

externally; grooves wide and round, anterior and posterior margins extended a little beyond the ridges, surface minutely punctated; mandibular tooth narrow and inner border gibbous, otherwise is the same as the palatal. No drawing has been published, and I cannot illustrate the tooth, for the reason given above.*

C. obtusus, T. P. Barkas. From the Northumberland Coal Measures. The palatal tooth was described by Mr. Barkas in the 4th volume of the "English Mechanic." The tooth is strong; flat; approximately ovate; $1\frac{1}{8}$ inch long; 1 inch broad; inner margin regularly arched; outer margin has a wave-like serration arising from the roundness of the extremities of the projecting ridges; the four posterior ridges and their accompanying furrows have an undulating appearance, the grooves and ridges being equal in width; the anterior ridge is broad, flattened, and slightly concave; upper surface boldly punctated and ridged, the edges of which have a tendency to inosculate; much of the surface has, therefore, a reticulated appearance. Mr. Barkas adds—"That the only tooth with which it is likely to be confounded is *C. ellipticus*, but a very slight examination will show the contrast that exists between them."

C. quadratus, T. P. Barkas. From the Northumberland Coal Measures, was described in the 18th volume of the "English Mechanic," but it has not been illustrated. The teeth of this species vary slightly in size, but the tooth I figure in Fig. VII is about the average; the inner margin is bent almost at right angles, a little external to its centre; the outer margin is also bent about the same place, but not so abruptly, possessing more of a curve; this peculiarity of the margins gives the tooth a quadrate form; the outer margin is irregularly waved from the ridges projecting beyound it; the ridges, six or seven in number, radiate from the inner angle; they are not tuberculated, being smooth and angular; upper surface finely pitted and showing a tendency to reticulation.

C. ovatus, T. P. Barkas. From the Carboniferous Limestone of Derbyshire. Only one tooth has been discovered; it was described in the 2nd volume of "Scientific Opinion," and was figured in "Coal Measure Palæontology." I have not the founder's description at hand, but I herewith give a copy of his lithograph, Fig. VIII.

C. interruptus, T. P. Barkas, was founded on a tooth in the York Museum, and was described in the same paper as *C. ovatus*. I cannot describe this species, for I have never seen it, nor has it been figured, and as I have said, I have not at present access to the 2nd volume of "Scientific Opinion."

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* This tooth has the greatest resemblance to a tooth of *Ceratodus*; the latter tooth has six ridges instead of five, the plate does not extend beyond the anterior and posterior margins, nor is it so large.

C. caudatus, W. J. Barkas. From the Northumberland Coal Measures. The specimen that I pourtray in Fig. IX is the only one that has been discovered as yet. It resembles *C. ellipticus* to a certain extent, but it differs in being smaller and in having a long projection from one extremity; this prolongation is not the result of a fracture nor is it a fold of shale, for I have freed the tooth completely from the matrix of shale; the posterior ridges are rather indistinct, having probably been worn away during life; but traces are left of four non-tuberculated ridges; the anterior ridge is broad, much inclined forwards, and projects beyond the outer margin; the under surface is smooth, and a ridge runs horizontally along its centre from the back of the prolongation; the tooth is 1 inch long, including the tail, and ¼ of an inch broad.

I have now described the characters of the teeth of every species that has been discovered, and with which I am acquainted. In my next paper I shall refer to the microscopical structure of these teeth, and illustrate it by drawings taken with the camera. Fortunately all the teeth I have described possess the same structure, there will, therefore, not be any necessity to go over all the species in detail again. My further programme is to pourtray the incisive or vomerine teeth, the mandibular, palatal, and articular bones, and the dental arrangement; next, the head bones, ribs, operculæ, &c., &c. By this means all that is known of *Ctenodus* will be brought together for the first time into a series of consecutive papers, and comparisons with the similar parts of *Ceratodus* will then be more easily made.

In order that comparisons may be at once instituted between the teeth of *Ctenodus* and those of a recent *Ceratodus*, I herewith append Dr. Günther's description of the external characters of the teeth of the latter fish, which appeared in a paper on Ceratodus in the "Philosophical Transactions," Part II, for 1871:—

"Each maxillary dental plate is an oblong piece, with a grinding surface, a convex inner side, and with the outer side divided into six prominent trenchant ridges or prongs, by five notches, of which the foremost is the deepest, the others becoming shallower posteriorly. The foremost ridge passes to the inner border of the tooth, which is likewise somewhat raised. The grinding surface has a great number of minute depressions or punctuations. The total length of a maxillary tooth is 1¼ inch, and its greatest width ½ an inch. In form and size the mandibulary teeth are very similar to the maxillary, only the grinding surface is less uneven. These teeth are anchylosed to the bone, and inserted in an oblique direction—the upper teeth nearly meet each other in the median line, but there is rather a wide interspace between the lower." Fig. X. is a maxillary tooth copied from Günther's monograph, plate XXXIV, fig. 3.

Discussion.

The Rev. W. B. Clarke, Chairman, said that Dr. Barkas had studied the *Ctenodus* chiefly from the teeth, and had compared these with the teeth of *Ceratodus*. When he (Mr. Clarke) first saw the recent *Ceradotus* he examined the teeth, and pointed out to the Curator of the Museum that it was a *Ceratodus*, referring him to the plates in the *Poissons Fossiles* of Agassiz. Sir C. W. Thomson had also shown him fossil teeth of *Ceratodus* found embedded in the soil of Queensland. In the Geological Magazine for 1869 the father of Dr. Barkas had described the teeth of various species of *Ctenodus* found in the Coal Measures of Northumberland, and of some of these teeth figures were given as shown in the Magazine, vol. VI, produced.

There was a difference between *Ctenodus* and *Ceratodus*, yet they were related. It was a marvellous fact that a fish of such antiquity in Europe as *Ceratodus* should be found living at the antipodes. Mr. Clarke then exhibited to the meeting teeth of *Ceratodus* of several species from Wurtemburg.

Part II.

ON THE MICROSCOPIC STRUCTURE OF THE MANDIBULAR AND PALATAL TEETH OF CTENODUS.

By W. J. Barkas, M.R.C.S.E., L.R.C.P.L.

[*Read before the Royal Society of N.S.W.*, 4 *October*, 1876.]

In my last paper I described the external characters of the teeth of all the species of this genus that have been discovered, and hinted at the classification and probable distribution. To-night I shall draw your attention to the minute structure of the teeth, and as I find from my investigations that they possess a similar structure in all the species, I shall take *C. tuberculatus*, this species possessing the largest teeth and being the most common, as a typical tooth. *C. elegans* apparently differs in structure but in reality it does not do so, as I shall show in the course of my remarks.

Professor Agassiz, while describing the different species in his "Poissons Fossiles" that were known to him at the time of publication of that great work, refers to the structure of *C. Robertsoni* only, leaving it to be conjectured that it was the only species he

examined, or that the other teeth had a similar formation; he figures a section magnified a very few diameters, which only shows the medullary canals branching and anastomosing in an homogeneous matrix, and such is the opinion the Professor held of the minute anatomy, for he distinctly states that there are not any calciferous tubules nor canaliculi (*sic*) permeating the osseous part of the tooth. Undoubtedly he was right in pourtraying what he saw, but we will see shortly that even with a low power dentinal tubules can be easily perceived, and that when they are absent it is because of the thinness of the section.

Professor Owen, in his "Odontography," remarks that the texture presents a coarse osseous base supporting a dense osseous or enamel-like layer, which statement is very indifferent and might be applied to a great number of the teeth of Cestraciont genera and species. Many years after the appearance of this work, Professor Owen published a booklet entitled "On the Dental Characters of Carboniferous Fishes and Batrachia," but which was immediately withdrawn from circulation, as it was at once seen that every tooth he described and had raised into a new genus or species had been known, named, and described years previously. Among these so-called new genera was *Sagenodus*, the species *inequalis*, the description of which was accompanied by beautifully coloured lithographs, but neither the letter-press nor the figures differed in one essential point from the account of *Ctenodus* structure as published by Messrs. Hancock and Atthey in the "Annals of Natural History" and the "Transactions of the Northumberland and Durham Natural History Society."

A somewhat brief description of the minute structure of these teeth was given by Messrs. Hancock and Atthey in a paper entitled "Notes on the Remains of some Reptiles and Fishes from the Shales of the Northumberland Coal Field," which appeared in the 3rd volume of the above "Transactions"; they took *C. cristatus* for their purpose; they, however, did not figure the structure.

Mr. T. P. Barkas does not refer to the microscopical characters in any of his writings on this subject, but he gives coloured lithographs of them in the "Atlas" accompanying his "Coal Measure Palæontology."

This is all the literature bearing upon this portion of my paper, and it will be seen that it is too meagre for purposes of comparison; the figures, however, of Agassiz and Barkas are excellent considering the low powers they employed. As I have said, the structure of the teeth of *Ctenodi* is similar in detail whatever species may be taken, but undoubtedly they can be made to differ markedly to all appearance by cutting sections in different situations and directions, but when a section of a tooth of one species is compared with an exactly similar cutting of the tooth of another these differences disappear.

But before entering into the microscopical structure I wish to quote Dr. Günther's remarks on a vertical section of a tooth of *Ceratodus*, as the characters he describes are identical with those of a tooth of *C. tuberculatus*, *C. cristatus*, &c. "In a vertical section of one of the grinders it is seen that the real depth of the tooth (that is, that portion which is formed by dentine) is much less than it appears from a merely outward inspection. It rests, in fact, on an elevated plateau of the dentary bone, which has exactly the same outlines as the tooth itself, and the substance of which passes so gradually into that of the tooth that it is only by the difference in the shade of colour that the boundary between osseous base and dentinal crown is indicated. This anchylosis, however, is limited to the circumference of the base of the tooth; for its central parts are separated from the bone by the extensive but shallow pulp-cavity. We must remember that our specimens of living *Ceratodus* are by no means aged individuals, certainly much smaller and younger than those gigantic individuals of extinct species must have been, of which teeth two and more inches long are preserved. In such fossil teeth no pulp-cavity is visible, but the dentine passes into the bone across the whole base of the tooth. It is not at all improbable that the pulp-cavity disappears altogether with age." The last remark concerning there not being any pulp-cavity in the teeth of fossil *Ceratodi* certainly does not apply to the teeth of *Ctenodi*, for I have examined vertical sections of teeth of *C. tuberculatus* that displayed just as distinct pulp-cavities as we see in similar sections of the teeth of *Ceratodus Forsteri*, and others again that exhibited no trace of such spaces. Dr. Günther's hint as to the presence or absence of a pulp-cavity being an indication of age is, in my opinion, undoubtedly true when applied to the teeth of *Ctenodus*.

A vertical section of *C. tuberculatus* taken either from before backwards, or from side to side, when slightly magnified, shows that the osseous tissue of the tooth is exceedingly freely permeated by medullary canals, which are very large in diameter, and which branch and anastomose with each other frequently but yet in a very irregular manner, so that the tissue presents an appearance of a network of vessels, the meshes of which vary much in size. Though this is the aspect observed in a brief glance, a closer inspection makes evident that there is a tendency of the canals towards a certain course, and towards a regular method of branching also, in some parts of the tooth; for the arrangement of these tubes varies according as to whether we examine the base, or plate as it is usually termed, or the ridges with their tubercles. We have in these two parts fundamental differences of structure, apart from the characters of the canals, the plate possessing certain features found in true bone structure, while the ridges present characteristics that are purely dental.

The base or plate when cut vertically and examined under moderate powers, presents large canals traversing the bony substance, and which gives off branches at all sorts of angles. These branches vary slightly in length, but they are always short and soon anastomose with each other. The irregular branching and ready inosculation, combined with the fact that the diameters of the branches are quite as great as those of the main vessels from which they arise, cause the base to appear riddled with an irregular open network of vessels; nor does this character alter when the base is taken horizontally, thus showing that the canals at this point have not any particular course. The proportion of bone tissue to canals is about equal. The canals in this part of the tooth do not give off any ramuscles to penetrate the osseous substance. The bone, however, is supplied with nutriment by means of lacunæ. These lacunæ, or bone-cells, are characteristic of true bone; but in this tissue they differ from those of true bone in their form and arrangement. They are numerous, and are not arranged in concentric circles round the canals, but are dispersed throughout the bony tissue in an irregular fashion. In size the bone-cells are large, and present more of a reptilian character than of a piscine. In a vertical section the lacunæ have an exceedingly elongated form, the long diameter being frequently parallel with the course of the medullary canals they accompany; but often they lie without any such order. When cut transversely through the centre the cells assume an almost circular form. The bone-cells vary somewhat in length and breadth. All the lacunæ give off canaliculi, which ramify in the osseous substance, and inosculate with canaliculi springing from neighbouring lacunæ or else empty themselves into the adjoining canal. In order to examine these lacunæ with their canaliculi, it is not necessary to use high powers on account of their size, but they are often absent in sections, this being due to the cuttings having been made too thin, and the lacunæ ground away altogether. The bone tissue is homogeneous, no structure being observable under any power of the microscope.

As we follow the network of medullary canals to the upper surface of the plate we find that it gradually assumes a more regular appearance from the canals becoming smaller in diameter and pursuing a more vertical course near the junction of the plate with the ridges; the network slowly changes and becomes obliterated. This alteration is caused by the branches that are given off by the main canals arising at a more and more acute angle, and pursuing a more and more vertical course, thus necessitating anastomoses of the branches with each other at higher points than their places of origin—the branches still present a similar diameter to the parent canals. The bone tissue at the same time becomes more and more out of proportion to the

canals, that is, it increases in quantity, but the addition is never in great excess, the sections, whether vertical or transverse, always having an open structure. The bone substance still remains homogeneous, but it often presents a laminated appearance immediately surrounding the canals; lacunæ are to be seen, but they are much smaller, more rounded, and few and far between.

On a level with the bases of the ridges, the network character of the medullary system is quite lost, and the structure of the ridges and tubercles presents a totally different arrangement from that of the base; when a low magnifying power is employed for observation the change seems to be sudden. The canals are now much decreased in diameter, run in a somewhat vertical manner, give off branches at a very acute angle, which anastomose with each other very freely after pursuing a short vertical and oblique course. From these causes, a section when examined appears filled with very short vertical tubes, as is portrayed in Fig. X., which is a vertical section of a tubercle of *C. tuberculatus* magnified 20 diameters. The osseous substance immediately surrounding the medullary canals is laminated, and the concentric rings are darker in tint than the unlaminated portion of the tissue; the whole, however, is homogeneous, and the lacunæ have disappeared. From the canals spring numerous dentinal tubules, which run a very short course and branch once or twice on their way in a dichotomous manner. The tubules of one canal inosculate by their terminal branches with those of a neighbouring canal, and they also undoubtedly anastomose with the tubules adjoining that arise from the same main vessel. These tubules are often not visible in sections, sometimes from the Canada balsam, which has often the same degree of refrangibility as the fossil substance, permeating them, but more frequently they have been ground away in attempting to make a thin section. Fig. XI. represents a portion of a medullary canal cut vertically, and shows the laminated character of the osseous tissue adjoining, and the tubules springing from the canal as seen under a magnifying power of 250 diameters. The structure I have just described is present throughout the ridges and tubercles.

Immediately external to this tubular portion of the ridges and tubercles on the upper surface of the tooth is a thin layer of dense tissue, unpermeated by the medullary canals or their tubuli, and apparently without structure. When an unworn tooth is examined there is perceived external to the above dense layer a coat of ganoine or fish enamel, which is also structureless; this covering, however, is rarely seen, for it appears to have been very easily worn away by the friction which trituration of hard substances with teeth like these would cause.

It only remains for me to notice *C. elegans*. On account of the extreme thinness of the plate of the tooth of this fish, it is impossible to cut vertical sections similar to those we have employed in observing the structure of the teeth of the other species of *Ctenodus*. Even in taking transverse sections, it matters not how carefully one may attempt to make them, it is also impossible to cut below all the tubercles, which are large compared to the size of the tooth; we have, therefore, an appearance presented to us of bulbous ridges; in Fig. XII, however, the first ridge has been taken pretty fairly, the bulbous aspect only appearing near its apex. In a section like this we still find the two varieties of structure that we noticed in *C. tuberculatus*; Fig. XII, however, does not exhibit the network character of the medullary canals in the base of the plate of the tooth; but I have observed that feature in other specimens that have been more fortunately ground; it does illustrate, though, the vertical tendency of the course of the canals in the upper part of the plate and in the ridges and tubercles, for both Figs. XII and XIII show them cut transversely across as they were proceeding towards the upper surface. From these canals dentinal tubules are given off which ramify in the clear osseous tissue that is observable in the centre of each tubercle. The peculiar radiate form of the bone substance in the centre of the tubercles is due to the medullary canals grooving the mass on their course upwards, leaving processes of clear transparent bone between them. External to the medullary formation we have the layer of dense tissue, and covering that, in unworn specimens, there is a coat of enamel.

Part III.

ON THE VOMERINE TEETH OF CTENODUS.

By W. J. Barkas, M.R.C.S.E., L.R.C.P.L.

[*Read before the Royal Society of N.S.W.*, 1 *November*, 1876.]

In the spring of 1874 I discovered two teeth in the shale of the Low Main Coal Seam in the Carboniferous formations of Northumberland, that were quite new to me and to all Coal Measure palæontologists to whom I submitted them, and in none of the numerous works to which I then had access were there any

figures or descriptions of fossil teeth at all similar, either in their external form or in their internal structure; the teeth that most nearly resembled them were certain varieties of *Petalodus* described and figured in Newberry and Worthen's Geological Survey of Illinois, U.S. One palæontologist whose knowledge of fossil fish teeth is second to none, submitted that they might be a variety of *Petalodus*, for in many respects their external characters agreed with those of some teeth of that genus discovered in America. So far as the outer appearances were concerned I inclined to agree with this judgment, but when I had made a microscopical examination I saw that in structure at least, these teeth differed very much from the minute anatomy of *Petalodi* teeth; I, therefore, provisionally only, named these new dental organs as pertaining to a fish of the genus *Petalodopsis*, and gave them as a specific name *mirabilis*, on account of the structure. A description of the external characters and the internal structure appeared in "The Monthly Review of Dental Surgery," for May, 1874, as one of a series of papers I was publishing therein "On the Microscopical Structure of Fossil Teeth from the Northumberland True Coal Measures."

These two teeth were discovered on separate pieces of shale, and were unaccompanied by any other remains, I, therefore, in the above paper, hinted that *Petalodopsis* was probably a Selachian; I also mentioned, however, that one of the features of the internal structure was unlike any structure that I had seen in the teeth of any fossil fishes, labyrinthodonts, reptiles, or mammals, while the rest of the characters of the minute anatomy closely resembled those of the mandibular and palatal teeth of *Ctenodus*. As I had not at that time seen *Ceratodus* nor read Dr. Günther's paper, I did not receive the hint that the latter observation might have given me, viz., that the strange teeth that I had named provisionally as *Petalodopsis mirabilis* were really the incisor or vomerine teeth of *Ctenodus*. It was reserved for Mr. T. Atthey to make this observation, which he did in the "Annals and Magazine of Natural History," for May, 1875, in a paper "On the Articular Bone and supposed Vomerine Teeth of *Ctenodus obliquus*"; he therein says—"On a thin slab of shale from Newsham (this is the pit from which I obtained my specimens) in my possession, and which measures 5 by 3½ inches, are seen imbedded one rib, several bones of the head, fragments of scales, and what I take to be right and left vomerine teeth of *Ctenodus*." He then briefly describes the teeth, and closes his remarks by stating that "the microscopic structure of these teeth corresponds exactly with that of the maxillary teeth of *Ctenodus*. I possess about a dozen other specimens believed to be vomerine teeth of *Ctenodus*, in close proximity on the same slabs to the bones of the head and teeth of *Ctenodus*." Mr. Atthey's

statement concerning the structure, we will see hereafter, is not altogether correct. Accompanying the above-quoted paper were illustrations of the vomerine teeth, which do not differ from those I had figured a year previously. Mr. Atthey does not state why he supposes these teeth to belong to *Ctenodus* but he leaves it to be inferred that his belief is founded upon discovering them often accompanied with undoubted remains of *Ctenodus*, nor has any other proof than this been yet obtained; still, knowing as we do that *Ctenodus* is similar in its details to *Ceratodus*, we are justified in supposing that it also possessed vomerine teeth. *Ctenodus* is also very closely allied to *Dipterus*, and Dr. Günther considers that he has evidence to show that the latter fish possessed vomerine teeth, for he has found a head with fang cavities situated just where the incisor teeth should have been; the vomerine teeth of *Dipterus*, however, have never been discovered. Should this statement of Dr. Günther be correct, it is rendered more probable that *Ctenodus* was armed with similar oral appendages. To the facts that these petaloid-shaped teeth are found associated with remains of *Ctenodus*, that the allied fishes *Ceratodus* and *Dipterus* have vomerine teeth, we must add that they have a certain degree of resemblance in form to the known incisor teeth of *Ceratodus* which are thus described by Dr. A. Günther:—"The vomerine teeth are broad and rather low laminæ with a convex and trenchant margin, the outer or posterior part of which slightly serrated. Each lamina is 13 millims long, and in the middle 5 millims deep. They are inserted in an oblique direction to the longitudinal axis of the vomer, and meet in the middle at a right angle; being implanted in cartilage, they are slightly movable."

A vomerine tooth of *Ctenodus* "presents some rather peculiar characteristics; it is 2-5ths of an inch in height, about the same dimensions from side to side at the broadest part, which is near the superior border, and 3-10ths of an inch in thickness at the lower portion of the base. The tooth presents two portions, a crown and a base, which are only distinctly separated on the posterior surface; I shall not, therefore, describe them separately, but take the tooth as a whole. The posterior surface (Fig. XIV) is somewhat triangular in shape, with the apex pointing downwards; it is concave from above downwards, the concavity being most pronounced near the lower border of the tooth, where the apex of the triangle is bent backwards rather abruptly; the upper portion of this surface is smooth, shining, and minutely pitted; the lower is irregularly pitted, the depressions being comparatively large, the raised portions round the pits give this part of the surface a coarsely reticulated as well as pitted appearance. The anterior surface (Fig. XVI) is divided into a crown and a base; the crown is convex from above downwards

and slightly so from side to side, the vertical convexity being most marked where the crown rises from the base; the surface is smooth, shining, and covered with minute pores; the base is concave vertically and convex from side to side; it is rough, from the large punctations and the coarse reticulation; this surface of the base is triangular, and the apex is pointed downwards and curved forwards, giving the base, in a side view, the appearance of a heel (Fig. XV) or process protruded from the back of the tooth proper, as in the teeth of Janassa, but in this case a bony mass unites the anterior and posterior points and makes the whole a solid osseous base. The superior border is convex from side to side, and ends at one extremity very suddenly as though a portion had been broken away, which is not the case, this being a genuine character of the tooth; there are five denticles on this margin, those on the most rounded portion being the best defined; the denticles resemble broad, flattened tubercles, with a smooth and shining surface.

"In the base the vascular canals are very numerous, and run apparently at right angles to the vertical axis of the tooth; those near the inferior border are larger than those near the junction of the base with the crown, the decrease in size being gradual, the variation in diameter being from $\frac{1}{100}$th to $\frac{1}{800}$th of an inch; the canals at the inferior border are patent, and at the superior border are continuous with those of the crown; those that extend to the external surfaces remain open, not being closed in by dentine or ganoine. Branching occurs freely, the branches being given off apparently at all angles; a vertical section of the base has, therefore, somewhat of a reticulated appearance (Fig. XVIII). The tissue between the vascular canals is homogeneous, and is not arranged around them in concentric layers; the proportion of tissue to the sum of the diameters of the canals is nearly equal, that is, the tissue situated between two canals is on an average about equal to the diameter of one of the canals. From all the medullary canals spring numerous calcigerous tubules, which branch and inosculate very freely; the branches arising from the same trunk anastomosing with each other and with the branches from neighbouring systems; besides this frequent anastomosis the branches are freely interlaced one with the other, so that it is difficult to examine their arrangement, and it renders the tissue of the interspaces dark and cloudy; the course of those that can be examined satisfactorily is observed to be short and wavy. The average diameter of the tubules at their origins is about $\frac{1}{8000}$th of an inch.

"In the crown the canals are still numerous, and though they are continuous with those in the base, they have undergone certain marked changes in their course, &c., the change occurring

at the junction of the base with the crown; their course is now directly parallel to the vertical axis of the tooth, and they are almost parallel to each other; branching still occurs, but not so frequently as in the base, and the branches are given off at a more acute angle. This arrangement of the canals gives the crown the appearance of being composed of a series of upright tubes (Fig. XVII) when a vertical section is examined under a low power. The canals are smaller in diameter than those in the base and also more uniform in size throughout their course, the average diameter being $\frac{1}{300}$th of an inch. They are open on all the external surfaces, this giving rise to the pitted appearance thereon. The tissue between the canals is homogeneous and not laminated, and they are in about equal proportions. From all the canals arise calcigerous tūbules, which are short and run a straight course; they branch frequently, and the terminal branches anastomose with those from the nearest vascular canals. The intermediate branches inosculate with others given off by the same trunk or with those arising from neighbouring tubules, but which spring from the same canal. They measure at their origin about $\frac{1}{8000}$th of an inch in diameter and the minute branches average about $\frac{1}{30000}$th of an inch, but the extreme terminal branches can only be observed under a power of 600 diameters; they have, therefore, an exceedingly small, almost immeasurable, diameter. Fig. XIX gives an excellent illustration of the method of branching pursued by these tubules." I may observe that this arrangement is totally different from that of any tooth structure that I have investigated under the microscope, whether fossil or otherwise. "The tubules arise by a comparatively large trunk, which immediately gives off from all sides a number of short fine tubules, some of which are larger and longer than the others. These larger branches in their turn give off minute branches in the same manner as the parent stem; the trunk of the tubule after proceeding a short distance divides into two main branches, which give off two sets of tubules like the main portion of the tubule. This process of double division goes on until anastomosis takes place with the terminal branches of a tubule from a neighbouring canal. Each tubule and its main branches divide dichotomously. Although the figure I have exhibited shows the peculiar structure very fairly, it requires at least 600 diameters to do so perfectly, and even under that high power it requires a trained eye to detect the minute branches dividing once again. I cannot better express in words the peculiar method of branching of the tubules and the main branches than by remarking that they are 'feathered.'"

Such is the account I gave of a vomerine tooth of *Ctenodus* in my papers to the "Monthly Review of Dental Surgery" for May and June, 1874; but at that time I considered it to be a

new tooth, which I provisionally named *Petalodopsis*. Through the kindness of Mr. W. Macleay, who supplied me with two vomerine and two palatal teeth, I have had the opportunity of examining the structure of the vomerine teeth of *Ceratodus* under the microscope. I made a vertical section, and was pleased to find that the fundamental structure was similar to that which I have just described. Still there are marked points of difference, for in *Ceratodus* the tissue is greater in quantity than the sum of the diameters of the canals, and the calcigerous tubules are not feathered, but they do branch as we observed the tubules in the palatal and mandibular teeth of *Ctenodus* to do. Externally also the incisor teeth of *Ctenodus* and *Ceratodus* are essentially similar, both being evidently constructed to answer the same purpose. In minutiæ, however, there are differences by which one could easily distinguish the one from the other.

Judging from the anatomical, microscopical, and palæontological evidence before us, we can have little doubt concerning the teeth I have just described. They pertain to *Ctenodus*, and so far as we have progressed in the descriptions of the different parts of *Ctenodus* the evidence is strengthened that *Ctenodus* is closely allied to *Ceratodus*.

Part IV.

ON THE DENTARY, ARTICULAR, AND PTERYGO-PALATINE BONES OF CTENODUS.

By W. J. Barkas, M.R.C.S.E., L.R.C.P.L.

[*Read before the Royal Society of N.S.W.*, 1 *November*, 1876.]

We have now to leave those characters of this fish that are strictly dental, and enter upon the description of the different parts of its osseous structure, or rather, of those parts of it that are known to us, for a portion of the endo-skeleton has yet to be discovered, and necessarily many parts will not have been capable of fossilization. In the previous portions of this series of papers I showed that, in the external characters of the teeth of *Ctenodus* and also in their structure, there were many points of resemblance to the dental features of *Ceratodus*. To-night I intend to speak of the dental bones, more especially, pointing out their osteological characters, and incidentally I shall draw attention to the dental arrangements. We will then see that even in these points the similarity is pretty closely carried out between *Ctenodus* and *Ceratodus*.

The mandible or dentary bone is comparatively frequently discovered in the shales of the True Coal Measures of Northumberland, but no jaw has been brought to light in any other formation so far as my knowledge extends, and in all cases the tooth is found still attached to it. In those cases where teeth are discovered unconnected with the mandible (a frequent occurrence) or pterygo-palatine bone, they show evident traces that they were once anchylosed to the bone, in fact, we saw when examining the teeth microscopically that the osseous structure of the bone gradually merged into the true dental tissue. Mr. Atthey, in a paper that appeared in the Trans. Northd. and Durham Nat. Hist. Socy. vol. iv, states that he has obtained the dentary bones of *Ctenodus tuberculatus*, *C. cristatus*, *C. obliquus*, *C. elegans*, *C. imbricatus*, but I myself have only had the opportunity of examining the mandibles of the first and third species named above; this want of observation is, however, of no moment, as Mr. Atthey distinctly states that the variation in form is very slight, being mostly one of degree in size. Mr. T. P. Barkas, F.G.S., records in different periodicals his discoveries of mandibles, and figures one in his book "Coal Measure Palæontology," but Mr. Atthey, in conjunction with the late Mr. Hancock, were the principal authors on the different parts of the endo-skeleton of *Ctenodus*, and as their remarks are generally exact, I shall employ their words, for my descriptions could only be similar in regard to the facts. "In *Ctenodus* (*obliquus*) the ramus is a stoutish bone, flattened vertically, with the upper margin turned over towards the external surface to give support to the large dental plate; it is therefore channelled on the outer surface and somewhat convex on the inner. The posterior extremity projects backwards beyond the dental plate a little more than half the length of the latter, and is for the greater part occupied by the glenoid surface, which extends from the upper margin, and is a deep, wide, circular notch, inclining backwards and downwards. In front the symphysial surface is straight, extending the whole depth of the ramus, and is grooved transversely. The dental plate is about two-thirds the entire length of the ramus, and is placed nearer the symphysis than the posterior extremity. The ramus is upwards of 3 inches in length, and including the thickness of the dental plate, is an inch deep." Fig. XX pourtrays the inner surface of the dentary; the dental plate resting on the upper border; the symphysis; and the glenoid notch. Fig. XXI exhibits the other surface with the dental plate overhanging. I may explain that these figures are copies of drawings published by Mr. Atthey. I am not able to give original drawings, as my specimen was destroyed on my travels. From the above description it will be seen that each mandible possesses only one tooth, but Mr. T. P. Barkas, in a letter to the "Scientific

Opinion" or the "English Mechanic," I am not now sure to which nor have I access to them to find out, but in that letter he remarks that he has evidence to show that in one case at least the mandible and maxillary bones had each two teeth; however this may be, it is the general, if not universal rule, that each of these bones carry only one tooth. Putting aside the exceptional example mentioned by Mr. T. P. Barkas, no marked difference can be observed between this mandible and the mandible or dentary bone of *Ceratodus;* the similarity is carried further, in that both these genera have the lower jaw composed of two osseous portions, an inner or dentary bone and an outer or articular bone, which in the modern fish are held together by an intervening mass of cartilage and were presumably so united in the palæozoic fish. It was only recently that the articular bone was discovered, or rather, the bone had been found some time by Mr. Atthey, but he did not recognize it until he had had the opportunity of examining the articular bone of *Ceratodus*. In 1874 he verified his belief, for he discovered two specimens of the mandibular arrangement of *C. obliquus*, in which the dentary and articular bones were in their natural positions. These articular bones I have observed in the cabinet of Mr. T. P. Barkas, and I have one in my possession. It is this specimen that I pourtray in Fig. XXII. In describing this bone, Mr. Atthey states that it varies much in length—as much as from ¾ of an inch to 4 inches; he then proceeds:—"The articular bone of *Ctenodus* is of about the same length as the inner plate or ramus which bears the teeth, slightly convex on the outer surface, and marked by five or six apertures for vessels; it is pointed upwards in front like the prow of a boat. Its posterior border presents two scallops, the upper being somewhat larger than the lower, which extends to the posteriorly projecting point of the lower border, which is convex; the upper scallop ends at a rounded projection, which separates it from the upper border. This border presents two shallow concavities, the anterior occupying the greater part of the border; the posterior has a projection on its inner side, somewhat in the form of a bracket, for the support of the teeth of the inner plate or ramus." In the bone that I figure there are some slight points of difference from the above description, the inferior margin is not so curved anteriorly; the upper concavity on the posterior border is not so large as the lower one, nor does the superior margin present two concavities. With these minor exceptions, however, my specimen agrees with his account.

The pterygo-palatine bone (Fig. XXIII.) is a flat bone, situated along the front and sides of the roof of the mouth, having its antero-posterior diameter much greater than its lateral diameter; its posterior extremity is much more expanded than its anterior.

The anterior extremity is bluntly pointed and projects beyond the general body of the bone; from this process the outer border runs in a direction outwards and backwards and joins the posterior margin in a rounded point; this border is very irregular in outline from its alternate concave and convex curves, the bends themselves varying much in their degree. The posterior border presents two gentle concavities, which join a little to the inner side of the centre of the margin. The inner border presents anteriorly a surface for union with the similar portion of the opposing bone; behind this it forms a broad sweeping concavity outwards and backwards, and then a slight convexity just before its junction with the posterior border. The under surface bears upon its outer and anterior portion the dental plate; which plate projects somewhat beyond the bone, more especially at its posterior extremity. When the two pterygo-palatine bones are in position they are united anteriorly by a long suture, they then diverge widely in their progress backwards. In all these points this bone corresponds closely to the pterygo-palatine bone of *Ceratodus*, with the exception that the latter is hardly so expanded posteriorly. The peculiarity of this bone (and also that of *Ceratodus*) is that it occupies the position of two bones, the palatal and inner pterygoid, and it presents greatly the form that would accrue on the union of these two bones as they are observed in the fossil fish *Dipterus*. I may remark in passing, that *Dipterus* possesses many characters in common with *Ctenodus* and *Ceratodus*, more particularly as regards its teeth; but in the formation of its upper jaw there are, as I have remarked, two distinct bones which are united by a suture. The form of this bone in *Ctenodus* and *Ceratodus*, and the fact of the similarity that it has to the united palatine and pterygoid bones of *Dipterus*, conclusively prove that Dr. Günther was right in his conjecture that these two bones have been merged into one in the case of *Ceratodus*, and, as Mr. Atthey first pointed out, in the case of *Ctenodus*.

As I have not a pterygo-palatine bone with me at present, I have had to trespass again upon the drawings of my friend, Mr. Atthey. The engraving appeared in vol. iv of the Transactions of the Northumberland and Durham Natural History Society.

[Plates.]

Fig I

Fig II

Fig III

Fig IV

Fig V

Fig VI

I. Ctenodus tuberculatus. Nat. size
II. C. obliquus „ „
III. C. elegans „ „

IV. C. concavus. Nat. size
V. C. monocerus „ „
VI. C. imbricatus „ „

Fig. VII

Fig. VIII

Fig. IX

Fig. IXa

Fig. X

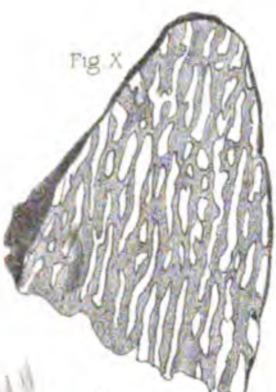


Fig. XII

Fig. XI

Fig. XIII

ST LEIGH & Cº LITH.

...quadratus Nat. size.
...ovatus „ „
...candatus „ „
...eratodus Forsteri Nat. size

X. Vertical section of a tubercle of C. tuberculatus Magn. 20 diams
XI. Medullary canal of C. tuberculatus, vert. sect. Magn. 250 diams
XII. C. elegans. Trans. sect. of tooth. Magn. 20 diams.
XIII. ... of tubercle Magn. 60 diams

Fig. XIV

Fig. XV

Fig. XVI

Fig. XVII

Fig. XVIII

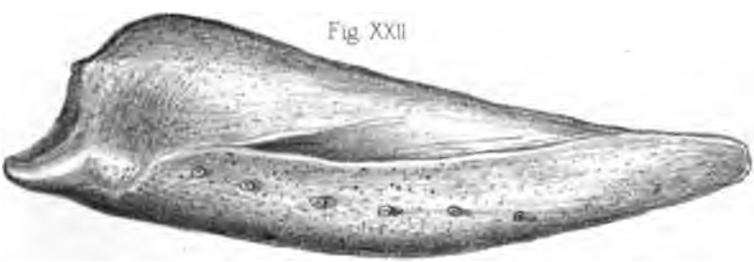
Fig. XIX

Incisor tooth of Ctenodus Posterior view XVII. " " vert. sect. of crown Magnified
" " " side " XVIII. " " " " base "
" " " anterior " XIX. " " " " crown " 600 diams

Fig XX

Fig XXI

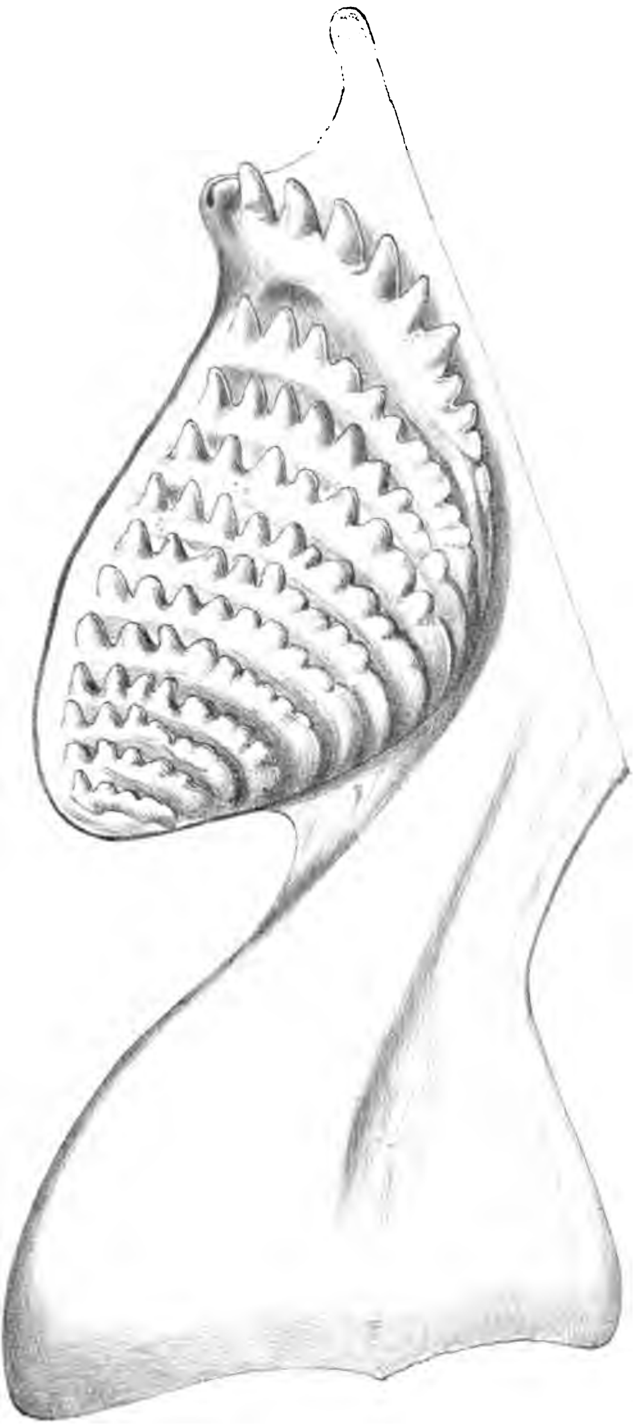
Fig XXII



S T LEIGH & Cº LITH

XX Mandible of Ctenodus imbricatus Inner surface. Nat size.
XXI . C. obliquus outer surface . „
XXII. Articular bone of Ctenodus. Nat size.

Fig. XXIII



ST LEICH & C° LITH.

XXIII. Pterygopalatine bone of Ctenodus tuberculatus. Nat. size.

ON THE FORMATION OF MOSS GOLD AND SILVER.

By Archibald Liversidge,

Professor of Geology and Mineralogy in the University of Sydney.

[*Read before the Royal Society of N.S. W., 6 September, 1876.*]

The origin and mode of occurrence of certain of the metals which are found in the free or native state, both in mineral veins and disseminated through various rocks, has for some time been a question of much interest to me; my attention, however, has hitherto been directed more particularly to the circumstances connected with the occurrence of native gold and of the minerals with which it is usually found associated; and it was while performing an experiment to ascertain, if possible, whether the gold which was known to be present in a certain specimen of mispickel, existed in the crystallized state, or was merely disseminated through the mineral in amorphous particles, that I first obtained the peculiar form of gold which I now have the pleasure to exhibit to the Society.

I have called this remarkable, and to myself hitherto unknown artificial form of the metal "moss gold," because in many respects it resembles the well-known "moss copper," hence it is convenient to use the above term for it; although it should be stated that none of the specimens of gold presented anything like so *velvety* an appearance as that commonly exhibited by moss copper.

One of the two specimens before me was a rich piece of mispickel from the Uncle Tom Mine, near Orange, I believe, and the other a somewhat richer specimen from Paxton's, or the Rampant Lion Mine, Hawkins' Hill, obtained from a depth of 200 feet. Both contained some visible gold, the first only a few small specks, but the second was fairly rich in free gold, although the amount was not to be compared to that which it now shows. Mispickel, I may remark, is a compound of arsenic, sulphur, and iron, combined in the following proportions,—

Iron	=	34·4
Sulphur	=	19·6 (or $FeAs_2 FeS_2$)
Arsenic	=	46·0
		100·00

The first specimen was roasted in a muffle in order to expel the sulphur and arsenic, and my intention then was to dissolve

out the oxide of iron and to examine the residual gold for crystals or any trace of crystalline structure which might be present, as I hoped by the above means to set the gold so completely free from the matrix that I could at once ascertain whether it existed in the mispickel in a crystallized form or only in irregular or amorphous lumps and particles.

On taking the specimen out of the muffle after the whole of the arsenic and sulphur had been driven off, I found that the surface was studded with small, irregular, more or less rounded excrescences of gold, having much the appearance and colour of small drops of sulphur. On closer examination, and especially with the aid of the microscope, the surfaces of these mushroom-like growths were seen to be covered with minute capillary wires and branching forms, which in some cases appeared to be made up of minute irregularly-formed crystals. This is more noticeable in the second specimen. Some of the cavities in the gold are seen to be lined with the most beautiful little spiculæ of gold, and some of the rounded bosses are composed solely of such spiculæ, interlaced into a ball-like form. Many of these capillary wires are curled into most symmetrical and beautiful spirals; one about $\frac{1}{2}$ to $\frac{1}{3}$ inch in length and of about $\frac{1}{100}$ inch in diameter is coiled with the utmost regularity, the pitch of the screw being maintained uniform throughout its entire length.

In some cases the mushroom-like growths are seen to be supported on but a very slender stem, while others have apparently become recumbent from their weight and have grown along the surface.

It is by no means an uncommon thing to find natural gold in the form of capillary threads, which are often interlaced and twisted into beautiful and fantastic shapes; also as thin flakes and scales, having a more or less fibrous surface; and at times in scales so exceedingly thin that they are not thicker than ordinary gold-leaf. Some of the gold from Oura, near Wagga Wagga, occurs in this manner. The best known Australian locality for filiform gold is, perhaps, the Upper Cape River, Queensland.

I should mention, however, that I have never seen or heard of any native gold presenting exactly the same kind of appearance as the before-described artificially-formed specimens, but certainly the latter is at times somewhat similar.

Origin of the Moss Gold.

The general appearance of these peculiar cauliflower-like excrescences of gold would at first sight tend to give one the impression that they had been formed in somewhat the same way as the blebs and excrescences often observed on coke, which are so familiar to us in a fire made of so-called bituminous coal—*i.e.*, caking coal, in which constantly we see portions of the coal fuse

and swell up into fantastic blebs and bladders until the imprisoned gas breaks through the thin skin and inflames with a brilliant light. After the more combustible portions have been volatilized and consumed, a hard, clinkery, and more or less cauliflower-like excrescence is left.

But I do not think that we can account for the form of these cauliflower masses of gold in a similar way, for the mispickel shows no traces of having undergone fusion, neither does the gold; the crystals of mispickel, which by the operation of roasting have become converted into oxide of iron, still retain their original form, even down to the jagged points along the sharp splintery edges of fractured surfaces. Hence it cannot be urged that the gold had merely been left in the form assumed by the fused mispickel in the same way that a cauliflower mass or capillary thread of coke is left by the escaping gas from a piece of fused coal.

Neither can the gold have been merely squeezed out through pores in the matrix by mechanical pressure in the same way that clay is forced through moulds in the manufacture of earthenware drainage pipes, for the enclosing matrix of mispickel during the operation of roasting becomes comparatively soft and tender. Hence it could not well offer sufficient resistance to the expansion of the gold to act as a wire draw plate, even if we suppose that the gold existed in the form of small pockets of metal, and that there are the necessary minute apertures and perforations in the mispickel through which the expanding gold could make its escape.

And again, the forms exhibited by the gold show that it has not been in a fused condition, neither does it appear even to have been of a pasty consistency.

To ascertain whether this remarkable form of gold was furnished by artificial mixtures of the metal and mispickel, or was solely confined to those occurring in nature, a series of experiments was commenced; and the results obtained satisfactorily showed that the same phenomena were presented by certain of the artificial mixtures employed.

Experiment.—80 grammes of powdered mispickel were fused under a film of borax with one gramme of precipitated gold. The whole of the gold was apparently taken up by the mispickel, for no metallic particles or shot could be detected in the fused mass of regulus. The button of regulus was then roasted at a low red heat in the muffle; it fused, but after the whole of the arsenic and sulphur had been driven off, the oxide of iron was found to be more or less covered with a brown, non-metallic looking cauliflower-shaped mass of gold. On scraping it with the point of a knife the unmistakeable yellow metallic streak of gold was at once exhibited.

Moss Silver.

Next a series of experiments was made in order to ascertain whether any light would be thrown upon the subject by the behaviour of silver compounds under somewhat similar conditions.

The first experiment was the reduction of silver chloride, in a bulb tube, by the passage of a current of pure dry hydrogen, mentioned by Dr. Percy, F.R.S., in his great work on "*Metallurgy*," and by other writers.

The silver chloride was allowed to fuse, but the temperature was kept very much below the fusing point of silver, so much so that the glass was not even softened.

The surface of the reduced metal was somewhat mammilated and cavernous, and it was found in certain places to be covered with minute capillary threads and spiculæ of silver; the cavities also were more or less filled with them.

Some silver sulphide was prepared in the humid way from silver nitrate. This was well washed, dried, and transferred to a French crucible, and then fused under a layer of borax in an ordinary melting furnace.

The mass of sulphide, weighing about 2 ozs., was then cut in two by means of a large knife and hammer, and one of the two parts roasted in a muffle furnace. The piece of silver sulphide was placed on a small scorifier just inside the mouth of the muffle, where for some time the temperature did not exceed the melting point of tin (*i.e.* about 442° F.) Within a very few minutes (between 10 and 15 minutes) after the lump of silver sulphide had been placed in the muffle, beautiful little growths of metallic silver were seen to be dotted over its surface, and particularly near the upper edges; the lower portion of the mass, to a height of about ¼ inch only presenting one or two points of silver at the right-hand end. This experiment was repeated several times with fresh pieces of the silver sulphide.

The projecting filaments had a most brilliant silver-white colour and lustre.

Their surfaces are strongly striated parallel to the length of the filament, and the larger ones are in most cases more or less curved or spirally convoluted. Towards the base the majority become much thicker, and in one direction they are usually much broader than in the other, hence they in this respect somewhat resemble blades of grass.

In certain instances the crystals could almost be seen to lengthen—a perceptible increase in length in more than one instance was observed within the space of between one and two minutes.

The crystals seem to increase in length and thickness far more rapidly during the first hour than afterwards, and their growth does not appear to be materially hastened by urging the tem-

perature—that between the melting points of tin and zinc (770° F.) appeared to be the most favourable. At a higher temperature the whole surface of the silver sulphide becomes covered equally with a coat of metallic silver.

The extrusion of the silver crystals cannot well be caused by pressure from without inward, for neither the silver nor the silver sulphide undergo fusion or even softening; neither can the production of the filaments be due to the simple and ordinary process of reduction by the removal of the sulphur as sulphurous acid gas, otherwise the whole surface of the mass of heated and more or less roasted sulphide should be covered with a coat of reduced metallic silver, just as when the sulphide is reduced in a current of hydrogen gas. But such is not the case; the extruded wires and filaments appear to be rooted in the sulphide, as if they pushed their way out from within, and they usually project out at nearly right angles to the surface of the apparently unchanged dark lead-coloured silver sulphide, just as Dr. Percy describes the formation of silver filaments, from the same compound under the reducing agency of a current of hydrogen gas.

It may be that their formation may have been determined by the presence of nuclei of some sort, just as in the case of various saline solutions.

On even the most searching examination I cannot detect any difference between the filamentous silver thus artificially formed and specimens of similar native silver.

Since making my experiments, I find that De la Beche says, in his "Geological Observer," p. 768:—

"Artificial sulphuret of silver was found to be readily decomposed by steam, and more easily so at a moderate heat. At a temperature under the melting point of zinc this was soon effected, and the silver effloresced in such forms as to induce Mr. Gustav Bischoff to regard the moss-like and filamentous occurrence of native silver in veins as very probably the result of the decomposition of sulphurets."

Moss Copper.

It is a well known fact that metallic copper occurs diffused through certain kinds of copper regulus, in the form of minute angular particles, which do not show the least trace of having undergone fusion; all the edges of these particles are sharp and not in the least rounded, and where cavities occur the metallic copper may be seen protruding into them in the form of minute points and hair-like threads or filaments.

Dr. Percy, in speaking of *moss copper* says*:—"In copper works this term is commonly used to designate those accumula-

* Percy's "Metallurgy," vol. i., p. 359.

tions of filamentous or moss-like copper, which are formed in cavities in pigs of certain kinds of regulus. Mr. Edward informs me that, in making copper from Cornish ores, moss copper seldom appears, but more of it is produced when these ores are melted in admixture with a little Irish ore (copper pyrites mixed with *much iron pyrites)* : it occurs most abundantly when foreign ores are much used. It is chiefly observed, and in the finest state, in *pimple metal*, when all the cavities are filled with it, and it is found protruding from the bottom of the pigs into the sand underneath; sometimes a little of it, strong and wiry to the touch, appears on the upper surface of the pigs. According to Mr. Edward, it may be seen in the little prills or shots of *metal* in the ore slag; and the surface of the pigs of metal from the *calcined metal* furnaces are covered with a coating of it, generally of a dark colour, and as thick as the nap or pile on velvet.

"In specimens in my collection the filaments of copper vary in size from the finest thread to fibres $\frac{3}{16}$ of an inch in diameter, and from one of three specimens obtained from a *fine-metal* furnace bottom I have taken separate filaments perfectly continuous, and exceeding 5 inches in length.

"Under the microscope the filaments present numerous minute parallel and longitudinal lines or grooves, as though they consisted of bundles of extremely delicate fibres. * * * * * * *

"The mode in which these fibres are produced is an interesting subject of inquiry. Each fibre seems to have been pushed, as it were, through a draw-plate, and at a temperature when the metal was soft, but certainly not exceeding that of well-melted copper, for otherwise the fibres immediately after their protrusion would have been remelted into globules." Then he goes on to mention that "filaments of silver, which, examined under the microscope, appear to possess *identically the same structure* as those of moss copper, may be formed by heating finely-divided sulphide of silver in a current of hydrogen at a temperature sufficient to agglutinate the sulphide, but below the actual melting point of silver. This beautiful experiment may be made in a glass tube, through which a current of the gas is passed. Long delicate fibres of silver may be seen protruding from minute rounded masses of the sulphide; and as they are produced while these masses are in a soft state, and lying free in the tube, the idea that they result from the application of external mechanical pressure in a similar manner to maccaroni, can hardly be entertained.

"There seems to be a force in operation at the base of each filament, which causes the particles of silver at the moment of liberation successively to arrange themselves in one continuous fibre or series of fibres; or, in other words, each filament grows, as it were, from a root imbedded in sulphide of silver."

Experiment.—I placed some lumps of native copper disulphide (*Redruthite*) in a hard-glass bulb tube, heated and passed current of hydrogen gas. After the experiment the whole surface of the mineral was found to be thickly covered with a nap of acicular filaments of copper. No traces of fusion were exhibited.

Dr. Percy also shows by a series of experiments that metallic copper is separated in a similar way by simply fusing some copper disulphide (Cu_2S.) in a crucible. And he further states that there is at present no certain knowledge of the cause which brings this about.

The foregoing results obtained by different eminent scientific observers, together with those yielded by my own experiments, afford, I think, some very interesting information, much important matter for reflection, and a large field for future experiment.

The conditions under which the formation of crystals have been observed may be briefly stated to be comprised by the following divisions; *i.e.*, crystallization takes place under the following conditions:—

Methods by which crystallization may be produced.

1. By condensation from a state of vapour.
2. From solution.
3. From a state of fusion.
4. By electrolysis.
5. By "spontaneous" change.
6. By thermo-reduction.

1. *Condensation* of a substance from a state of vapour—*e.g.*, iodine, arsenic, water vapour yielding snow and hoar-frost.

2. *Crystallization from solution.*—As when crystals of a salt are obtained by the evaporation of its solvent; and as when a solution of sulphur in carbon disulphide is allowed to evaporate spontaneously, beautiful crystals of sulphur are left.

3. *On solidification from a state of fusion.* This is commonly seen when metals such as bismuth, antimony, and others are allowed to solidify slowly. Beautifully crystallized examples of such metals and of sulphur may be readily obtained in the following way:—Melt a considerable quantity of the substance in a crucible or ladle, and when a thin coat has formed over the surface by cooling, pierce the crust and pour out the still fluid contents as quickly as possible. A large part of the metal or sulphur, as the case may be, will be left lining the inside of the crucible in the form of most beautiful groups of crystals with sharply defined edges and angles, and not as the rounded imperfect semifused-looking bodies that we might naturally expect when we consider the density and viscosity of the fluid in which they were formed and by which they were bathed.

4. *Crystallization by Electrolysis.* When solutions of the salts of the heavier metals are submitted to the action of electric currents, they undergo decomposition, and the metal which is deposited at the negative pole is usually more or less crystallized. A current of low intensity, *cæteris paribus*, seems to favour the formation of well-developed crystals. The reduction of a metallic solution by a more electro-positive element may probably be classed under this head, as stannic chloride by zinc, or silver nitrate by lead, and so on.

5. *Spontaneous Crystallization*, as it is usually termed, *e.g.*, the gradual passage of amorphous plastic sulphur into the crystalline state, also the similar change undergone by barley sugar. Many well known chemical precipitates apparently undergo spontaneously a similar change. Again, the gradual conversion of tough fibrous wrought iron into hard brittle iron with short grain, by repeated concussion and vibration, seems to be a variety of crystallization; certainly a great molecular change has taken place—but this matter requires further investigation. Then we have the passage of blocks of tin, which had been exposed to intense cold, from the malleable and non-crystalline to a fibro-crystalline and brittle state,—in fact, so brittle does the tin become that it more or less completely falls to powder.

The devitrification of glass may also be here mentioned.

6. *Crystallization by thermo-reduction.* I think that we may safely regard the forms exhibited by the artificially produced moss metals as varieties of crystalline forms, and with as much reason as the mineralogist assigns a place for the similar natural forms amongst crystals; the arborescent and other group forms assumed by native metals can be traced from normal and primary forms, such as of the octohedron and rhombic dodekahedron through various degrees of elongation and attenuation until we arrive at the filiform and capillary threads, a number of which aggregated together give in the velvet or plush-like mass of moss copper or other metal. Moreover, some portions of the gold reduced from the mispickle showed branching and arborescent groups which had all the appearance of elongated dodekahedra placed end to end in no way differing from natural specimens except in minuteness and perhaps greater brilliancy of lustre.

But these crystals have been produced by a process differing considerably from the methods enumerated in the first five divisions; hence the necessity for forming the sixth and last group.

The artificially prepared moss metals are produced by a process of reduction, aided neither by vaporization, solution, fusion, or electrolysis, neither are they produced "spontaneously," but they are prepared by the aid of a heated re-agent. Hence I have for convenience ventured to form a special class, *i.e.*, *crystallization by thermo-reduction.*

This matter is, of course, very closely connected with the ordinary metallurgical processes of reduction, but in such manufacturing operations no effort is made to obtain the metal in the crystallized state; on the contrary, it is the practice to favour the conversion of the metal into the liquid state as speedily as possible.

Although, perhaps, there may be no true analogy between the two cases, still it would be very interesting to calculate the amount of force requisite to produce the crystals, supposing that they had been mechanically pulled out like wires through a draw plate, or had been squeezed out through moulds similar to lead tubing.

I hope at some future date to be in a position to supplement the foregoing preliminary notes upon a question which is of great interest and importance in the chemical geology of mineral veins and deposits, when the series of experiments at present in hand are somewhat nearer completion.

DISCUSSION.

The CHAIRMAN said he could have brought some specimens of quartz in which the gold was exactly in the form of wire. In one case this wire was in the form of a true lover's knot. He was sure what they had heard to-night would lead to the explanation of some very curious phenomena. It had been said that volcanic heat melted gold from some previous condition. Now we know that some of our volcanic rocks could not have been at a great heat. In Victoria volcanic rocks lie upon vegetable matter, which has been only dried, not carbonized. If the quartz had been melted, the gold would have been all evaporated. It had been found that gold was lost in the Mint, and they wondered what had become of it. They swept the roof and the chimneys and found it there. So in certain lead works there had been accomplished a saving of £10,000 a year, by building long chimneys curved and extending backwards and forwards over some miles length, in which they collected the lead fume which had evaporated. This crystallization at a low temperature would explain many things. It remained a mystery how gold could be twisted and tied into a knot in the solid quartz where it was found.

Mr. H. C. RUSSELL said he hoped Professor Liversidge would be able to find out how these forms occurred. Crystals form out of very complex fluids. Each substance seems to have the power of taking to itself in crystallization those particles which belong to it, and rejecting those that do not. What we want to know is: *how* does the force of crystallization act? We know it was one of the forces active in forming meteorites from the primitive matter, which, according to the theory of La Place, once existed in the form of gas. And if the investigation which

Professor Liversidge is now carrying on shows us *how* crystals are formed on the earth, it will be one step forward in the investigation into the mysteries of nature.

Mr. DIXON, F.C.S., asked whether the silver was melted during the reduction. Did not the air raise the temperature of portion by the combustion of the sulphur; and would not that be sufficient to melt the silver?

PROFESSOR LIVERSIDGE said that the silver presented no trace of fusion. The temperature was ascertained by placing a piece of zinc and tin or cadmium close to the spot on which the sulphide of silver was; so that the two were kept at the same temperature. He did not think the increasing growth of the metal was due to the combustion of the combined sulphur. The crystals increased at a much greater rate in length and breadth than in thickness. The sulphide was reduced to a metallic state at a heat just about that of melting tin. The reduction did not take place regularly. These silver growths started out from particular points, and increased in size. It was not a case of mere reduction. If it were, they would get the whole surface of sulphide of silver equally reduced. The reduction seems to take place capriciously, as if the point were determined by some nucleus; fibres of silver stood out from the unreduced surface of the sulphide. One could almost see the fibres grow. There was a great change in a minute. It was generally supposed that the deposits of native metal could only have been formed by electric current or by the agency of great heat, perhaps assisted by the vapour of water. By these experiments it was shown that they could get metals in forms not distinguishable from the natural ones. He had in his hand a specimen of quartz containing filiform threads of gold. In most cases the contorted crystals occur in little cavities, not in the solid quartz. With regard to volcanic rocks only drying the vegetation under them, in the district of Etna people depended for their store of ice on the snow covered and protected by ashes overlaid by lava.

Mr. W. J. STEPHENS, M.A., remarked that when lava was running the part next the ground was tolerably cool; while what came over it was red hot.

PROFESSOR LIVERSIDGE, in answer to a question, said it did not follow from his experiments that the crystals obtained were pure gold. Moss copper is specially pure. Certain metals might perhaps be purified by this process.

He also stated that he was not at present prepared to put forth any very definite and final theory to account for the formation of the moss metals; the above communication was intended merely as a preliminary notice of certain results already obtained from a large series of intended experiments now in hand.

RECENT COPPER-EXTRACTING PROCESSES.

By S. L. Bensusan.

[*Read before the Royal Society of N.S.W., 4 October,* 1876.]

In the following paper I propose to make special reference to some of the new and improved methods known as "wet" processes for the extraction of copper from its ores.

Among the new methods which have been introduced, a variety of conditions exist, under which one or other has maintained its claims to the possession of some advantages over its competitors; in the main, however, they all aim at the extraction of the metal by processes requiring the smallest outlay in plant, &c., coupled with the minimum expenditure in chemicals and labour. Some metallurgists have sought to utilize bye products, as an auxiliary to other sources of profit; some have directed their attention to the simultaneous extraction of valuable metals sometimes associated with copper ores; a few have studied to perfect processes which are only available under certain *special conditions*, wherein the usual methods are not capable of being employed; and in cases where complicated mixtures have existed of metals, the extraction of one of which alone would not pay, many and ingenious devices have been resorted to, for utilizing and turning to profitable account portions of the constituents of the mineral which hithero have been a source of actual loss.

In the Australian Colonies the principal considerations which appear to suggest themselves, in connection with this subject, are,—the adoption of processes which do not necessitate the usual large outlay, and the utilization of such as are most available for particular districts, and to meet special conditions. One great desideratum is necessarily to make the *modus operandi* so clear and intelligible that it may be easily understood by most persons not possessed of special metallurgic knowledge. In a country like this, where the population is so scattered, and in which so much metallic treasure is known to exist, it is most desirable that a *resumé* of all that is generally known on the subject should be diffused; and while each inventor or discoverer of any new process only aims at the publication of his particular views and theories, and doubtless does much good, it is hoped

that a digest of the various plans adopted, a comparison of their merits, and an attempt to point out in which particular cases their individual excellence consists, may do much good in furthering the development of the Colony's resources.

It is sought to impress upon mineral explorers that methods are available for giving a value to mining property, without preliminary large outlay; but it is not intended to imply that, after inexpensive proof of value has been obtained, economy and profit may not be better attained by the introduction of labour-saving appliances, even at great outlay, though it is urged that the large outlay can be deferred until its justification is definitely and conclusively demonstrated.

Beginning with one of the most simple processes, and one with which most people are tolerably familiar, that known as the

Sulphuric Acid Process,

we find that in South Australia, at a mine of some reputation in times past, known as the Kapunda, the sulphuric acid process is in use for the extraction of copper from an ore containing only ⅝ of 1 per cent. of metal. But the conditions here are peculiarly favourable, inasmuch as the mineral operated upon consists of a vast heap of many thousands of tons of debris, or tailings, which have already passed through the dressing machine: consisting principally of oxides and carbonates, it requires no preliminary desulphuration; while the sulphuric acid is made on the spot from iron pyrites, which exists in great abundance on the property. The ore is digested in the acid until all the copper is dissolved out, several successive portions being treated in the same liquor up to the point of saturation; it is then allowed to settle, run off clear into a large vessel containing scrap iron, when the copper is precipitated at the expense of the iron in the form of cement copper, of about 70 per cent. The quantity of iron dissolved is equal to a little less than the weight of the copper precipitated, in neutral solutions; the cement copper is sold to the smelters, and has only to be passed through the refinery, and run into ingots. The acid is no doubt heated when used, and probably kept nearly up to boiling point, by the introduction of a jet of steam, and the material kept agitated to facilitate the action of the acid. Taking 16s. as the value of one unit of metallic copper, and seeing that this material contains only ⅝ of 1 per cent., or 14 lbs. of copper, in one ton of material, the gross value is only 10s., so that to yield a profit the cost of treatment, including the cost of sulphuric acid, labour, refining of the cement copper, and wear and tear of apparatus, must be less than 10s. per ton of ore treated.

Of course it is not supposed that we can readily find places in this Colony where the conditions will be precisely the same—

where the heap of debris already crushed will exist—where it shall consist of carbonates and oxides—where iron pyrites is found in abundance for the manufacture of sulphuric acid, &c.; but we can find many places where a little modification of the process may be made with profitable results—where large deposits of copper pyrites exist, containing 2 to 3 per cent. of copper, the pyrites itself serving in many cases for providing its own sulphuric acid, for the subsequent treatment of the oxidized or desulphurized ore.

THE SNOWDEN, OR LIME PROCESS,

is the next deserving of mention, on account of its simplicity and easy application in places difficult of access in the far interior, where the usual requirements of a reduction establishment and skilled labour would be difficult to obtain, and even valueless for the poor class of ores that may be treated by the process.

There are two necessary conditions to its application: 1st. That the ores, or a considerable portion of them, shall be sulphurets; and 2nd, that limestone be obtainable on the ground.

The process is as follows:—The mineral, containing copper pyrites is crushed, mixed with a small proportion (rarely exceeding 5 per cent.) of burnt lime; the lime and pyrites are then moistened and shaped by machinery into bricks, stacked, and roasted at a low red heat for a short time. The lime and pyrites undergo a double decomposition, the sulphide of copper being converted into a sulphate, and the lime into a sulphide of calcium. The bricks are then rapidly passed through a crusher into water, where the soluble sulphate of copper is at once removed; successive lots are passed into the same liquor, which becomes strongly acid; and if any oxide should have been present originally in the ore, or be formed by careless roasting, it will be dissolved out in the strongly acid liquor. After being allowed to settle, it is drawn off into another tank, and the copper is precipitated by passing hydrogen sulphide through the solution. The resulting product will contain 50 per cent of copper. The entire cost of treatment, inclusive of 10s. per ton for mining the ore, is about 20s. per ton, so that an ore of two per cent. could be worked at a very good profit, if the ore is plentiful and readily procured. The hydrogen sulphide is made from the ores themselves. Very little apparatus is wanted for conducting the process; a good bush carpenter could make the tanks of hardwood, taking care to use no metal in any part, at least inside, or at the joints; the bricks can be made by hand; the furnace for generating the hydrogen sulphide could be put up in a few days by an ordinary bricklayer working from a plan. The crushing of the ore will require some appliance, unless in the first instance it is reduced by a dolly, shod with iron, worked by a long lever, an appliance by which a few hundredweights can soon be reduced

by a strong boy. With only a moderate amount of instruction any person of average intelligence, and without any previous metallurgic knowledge, may conduct the process, even on a large scale. It derives its name from the Snowdon Mountains, where it is at present being successfully employed, and where, probably, no other known process would be available.

THE HUNT AND DOUGLAS PROCESS

is rapidly and deservedly gaining favour. It possesses several features that give it special claims to consideration. The apparatus used is simple and inexpensive; the treatment capable of being easily taught to an intelligent workman; the materials used in the extraction of the copper from its ores cost but little in the first place, and are capable of doing an indefinite amount of duty, with but little addition to supply inevitable waste; the precipitant is usually scrap iron, which, however, may be replaced with iron sponge.

In case the ore contains sulphur or arsenic, it is crushed, passed through a sieve of forty holes to the linear inch, and calcined. At the Ore Knob Mine in America the cost of the wood used in desulphurizing is found to be only one shilling for every ton of ore treated. The calcined ore is then treated with a solution of sulphate of iron and salt, of a certain strength, which experiment has found to be most effective; these are kept stirred in circular tanks, at a temperature of about 180 degrees Fahrenheit; the stirrers make about twenty-five revolutions, and the extraction of the copper occupies about eight hours. It is then allowed to settle, the clear part drawn off, and the turbid led into a settling vat. The copper is precipitated from a hot solution by scrap iron; the precipitation occupies twenty-four hours.

The rationale of the process is as follows:—Sulphate of iron and salt being dissolved and mixed together mutually decompose, forming sulphate of soda and chloride of iron; on the addition of ore containing oxide of or carbonate of copper (or the desulphurized ore), the chloride of iron reacts upon the copper, forming chloride of copper and dichloride, and precipitating the iron. In subsequently passing the solution containing these chlorides of copper over metallic iron, the copper then changes place with the iron, the former being precipitated as cement copper, and the regenerated chloride of iron solution being returned to the bath to act on successive charges of ore.

It will be seen that the cost of treatment is particularly small, but it may be added that the loss in treatment is less than half per cent., while the material employed in the extraction of the copper does duty many times. The one great source of expense, especially in situations far removed from the sea coast, is the iron used in precipitating; but in places where hematite is abundant they are commencing to make sponge iron to use

instead of scrap. The precipitation of one ton of copper takes about 13 cwt. of metallic iron, so that it is a very important item, a large proportion of the copper solution being dichloride. The bath of chloride of iron may of course be made by dissolving the metal in hydrochloric acid; the apparatus in which the operation is performed must be of wood, and no metal must be exposed to the action of the chemicals. The bath is prepared by dissolving 120 lbs. of salt, or 112 lbs. of dry chloride of calcium, with 280 lbs. of green copperas (sulphate of iron) in 100 imperial gallons of water; 200 lbs. of sea salt are then added; this quantity is capable of chlorodizing and dissolving about 90 lbs. weight of copper.

In case the ores contain gold or silver, the latter will be taken up by the copper solution, and can be recovered by digesting with metallic copper, while the gold remains in the tailings, which, being freed from copper, is in a condition admitting its easy extraction.

This process in the main is by no means new, though the original scheme of Robert Oxland has been greatly improved upon, and Messrs. Hunt and Douglas may be said to have given it a commercial value. In April, 1868, Oxland took out his patent for the extraction of copper from its ores by the use of ferric chloride, or chlorhydric acid. At home the latter was a waste product in the manufacture of salt cake, so that its use was less costly than the employment of salt. The precipitation was effected with metallic iron, and the bath was regenerated for the extraction of further quantities of copper. By the patent, however, it appears that after the first lixiviation Oxland dried the ore in a furnace, and subjected it to a second treatment, whereas Hunt and Douglas extract the copper in one operation, leaving only half per cent. in the tailings. Besides, the chemicals can be transported any distance in a solid form, which is no mean advantage, and the precious metals extracted at very small cost, while the whole of the reactions have been exhaustively studied by the inventors.

Stephen H. Emmens's Process

was patented on 16th July, 1875, its object being the economical extraction of all the valuable metals, besides copper, which may be associated with the ore under treatment. It consists essentially of three stages:—

1st. Roasting with or without salt to oxidize or chloridize the ore.

2nd. Lixiviating with water acid, or brine, to wash out the soluble metals.

3rd. Precipitating the dissolved metals from solution.

In the first stage he adds fluor spar; in the second or lixiviating stage he adds salt or saltpetre, and sufficient sulphuric acid to evolve enough hydrochloric or nitric acid to dissolve any

metals not previously in a soluble condition; in the precipitating stage the liquor is passed over iron pyrites or other metallic sulphides with a view to precipitate any gold and silver present in solution, ferrous sulphate being sometimes added to facilitate such precipitation. The liquor is next passed over metallic iron, copper, or zinc (according to its composition), to precipitate other metals present, in such order as may be most convenient; and, finally, if any other metals in solution, the liquor is treated with an alkali, to precipitate them, and then concentrated, or evaporated to dryness, to recover the saline substances for use in successive operations. A jet of steam is used during the two latter stages, to accelerate the reaction. When silver is present in the ore, salt is dispensed with and saltpetre substituted, to avoid its precipitation and loss in the lixiviating stage, or sufficient salt is used to ensure a saturated solution; it being well known to metallurgists that, while any chloride in dilute solution will precipitate the silver present, a saturated solution will arrest its precipitation. If no gold or silver were present, the liquor would not have to pass over metallic sulphides.

The process appears to possess great merit and value, especially in Australia, where copper is found associated with other valuable metals, the presence of which has hitherto detracted from their value instead of adding thereto.

Claudet's Process

for the extraction of copper and the precious metals from their ores is one of the notable economic methods for the treatment of particular kinds of mineral. Hitherto it has been principally applied to the treatment of cupreous pyrites with great success, the average contents being about 4 per cent. of copper and 18 dwts. of silver. The pyrites is roasted with salt, which converts the metals into soluble chlorides; it is then put into vats and subjected to eight or nine washings to extract the copper and silver. The first three washings take out 95 per cent. of the metals; this is all that is sought to extract of the precious metals, but the remainder is returned to the vats for re-treatment.

The silver present is precipitated by iodide of potassium, as an insoluble iodide, after previous titration, to ascertain the quantity required and avoid waste; acetate of lead in solution is also added, which ensures a precipitation of the chloride and aids in collecting the silver. It is then thoroughly shaken, and allowed to stand for forty-eight hours, when the copper liquor is drawn off clear; the tanks are filled for a further operation, and finally cleaned out once a fortnight. The precipitate contains a considerable quantity of copper, which is readily washed out with dilute hydro-chloric acid. The precipitate is next decomposed by the addition of metallic zinc, which reduces the silver to the metallic

state. At this stage gold, if present, makes its first appearance, having been dissolved in the first instance with the other chlorides, precipitated by iodide of potassium, and converted into the metallic state by zinc. The precipitate then consists of silver, with a small quantity of gold, lead (about 60 per cent.), oxides of iron and zinc, and a small quantity of lime and copper; there is no iodine present, as it has combined with the zinc in solution, from which it is recovered for further use. The copper solution, which has been drawn off clear from the silver precipitating tank, is passed into another tank containing metallic iron, which precipitates it at the cost of the iron.

At the Widness works the value of the precious metals contained in the ore is only (2s. 10d.) two shillings and tenpence; they consist of half an ounce of silver and one and a half grains of gold; the total cost of extraction is 10d. per ton of ore treated, and the profit 2s. per ton, on 30,000 tons treated primarily for copper. The method was first introduced in 1871, and in the first year 16,300 tons of burnt pyrites were operated upon; the *additional* expense connected with the extraction of the precious metals was £416, while the value of the gold and silver after deduction of the cost of melting and refining was £3,232. The process has been very largely employed since. In Cornwall there are mines producing large quantities of poor ores which have hitherto been treated in the dry way, for copper only, but have been found to contain more silver than the Spanish pyrites; these have recently been treated profitably by the process. In the first part of the process sulphate of soda of great purity is obtained, and the iron of the pyrites being very free from extraneous matter is recovered in a state of very fine division, used for polishing looking-glasses, and sold in large quantities to the iron manufacturers for "fettling" their puddling furnaces.

THE MINDELEFF PROCESS

is comparatively new, though the chemical theories involved are well known. The mode of applying these principles is certainly new. The inventor, a Russian metallurgist, has introduced his process into America, whence we derive details of the *modus operandi;* it consists of a new mode of applying light carburetted hydrogen as a reducing agent for oxides, sulphides, arsenides, and carbonates. The chemistry of the process has been long known, and various attempts have been made to utilize it, but hitherto without success. In California some experiments were made on copper ores, which were placed in a retort and heated to expel moisture; when sufficient heat was attained the gas was admitted under pressure, the escape pipe being adjusted to admit of the slow escape of the gases evolved. It is claimed that the process is a perfect success, the ore being thoroughly

reduced to a metallic state, subsequently to which it has to be run in a furnace and refined. It would be premature to offer here an opinion of the merits of this invention, and the mention of it is made here because the subject would be incomplete if it were ignored. Several attempts have of late years been made in Europe to reduce iron by the direct application of hydrogen, with more or less success.

The Ammonia Process

is the invention of Dr. Thomas Clarke and Mr. E. Smith, F.C.S., and specially intended for ores containing silver. If sulphides, they are roasted, to convert into oxides; usually, even after careful roasting, some of the copper and silver will remain in the form of sulphates, though the iron be completely oxidized; the rest will consist of oxides, and possibly a small quantity of metallic copper. The charge is then treated with calcic chloride, which removes all the sulphuric acid, forming calcic sulphate, while the copper and silver are converted into chlorides. At this stage ammonia is added, which forms chloride of ammonium; and this, with the free ammonia, dissolves the copper and silver, whether they exist as chlorides, oxides, subsalts, or finely divided metallic particles. The ammoniacal solution is then passed into a platinum tank, where the silver is deposited at the expense of the copper sheets in the tank, such copper being taken up in solution and recovered in a subsequent process. When all the silver is deposited, the solution is passed into a tank, a little caustic alkali added, and superheated steam admitted. The copper is precipitated as oxide, the ammonia being expelled, and recovered in condensers for subsequent use in fresh operations. At first sight it might appear that the cost of the ammonia would be considerable, but it is found that the loss is very small, nearly the whole being recovered without any additional expense; it is said to be in no way an objection to the process. The wear and tear of the platinum is infinitesimal, and the copper plates are easily renewed, while the copper dissolved is recovered. The copper plates require renewal only once in three months if fifty tons per day be worked. It is claimed that a very small amount will cover the cost of plant, while the material consumed is less costly than with any chlorinization process. In England calcic chloride is very cheap, being a waste product, but how far it would be available here remains to be ascertained. It would appear, however, that with oxides and carbonates the calcic chloride will not be required; and the same remark applies to ores *thoroughly* calcined, and containing neither sulphides nor sulphates. It is necessary that the ore be ground very fine, and that as much as possible of the sparry gangue shall be eliminated before treatment. Of course sodic chloride may be substituted

for calcic chloride. To the writer it has suggested itself that the use of any chloride *may* be dispensed with altogether, by simply passing the charge direct from the roasting furnace into water, when any sulphates that may have formed will be immediately dissolved, and after being thoroughly washed the charge would be ready for the ammonia, the solution of sulphates would be recovered in the usual way, and less ammonia would be required for the process. In fact, the larger the quantity of sulphates formed the cheaper the entire process, irrespective of the saving of chlorides in any form.

Other Processes.

In addition to the different processes above referred to, there are several others possessing a local value dependent upon certain special circumstances. One of the most notable is the process used at the Edgeley Hill works in England, where a very large body of poor ore, containing something less than two per cent. of copper, is crushed, and then treated with chlorhydric acid, to dissolve out the copper, which is precipitated with scrap iron. In this case the acid is a waste product, the ore very easily mined, the cost of the labour moderate, and iron procurable at a low rate.

The method of treating the copper schists at Mansfield is pretty generally known, but it may not be out of place to advert cursorily to it here. The ores contain from 1 to 4 per cent. of copper, existing in a bituminous schist; this schist is roasted in heaps, and after combustion being first communicated the bitumen present sustains it for a considerable time. It is then placed in a cupola blast furnace with coke. Matts and slags continually flow from the furnace, the former of which are again roasted, and again put back in the furnace. Repeated roastings convert some of the copper sulphides into sulphates, which are repeatedly lixiviated to separate the soluble sulphates. When any of the ore contains silver, it will come out with the copper; to extract it a quantity of lead is added to the black copper, and the alloy slowly heated in a furnace, when the lead will separate from the copper, and be found to contain nearly all the silver present; the proportions for effecting the liquidation are about one-fourth copper and three-fourths lead. Some lead will remain with the copper, which is subjected to a stronger heat, in a suitable apparatus, by which the whole of it is sweated out, the copper cakes remaining in a porous state, and being subsequently refined.

Remarks.

The study of the subject has convinced me that, where the extraction of the copper is the sole consideration in cases where the quality is pretty good, there is no process of reduction more

economical and more suitable than the old-fashioned smelting process. Few people, however, have the slightest idea of the difficulties that beset the owners of copper-smelting works, especially in a new country; the inefficiency of furnace-builders and smelters; the difficulty of procuring refractory clays, and making bricks that will stand; the want of sufficient knowledge of the chemistry of smelting, and the way of making suitable fluxing mixtures, the impossibility in some parts of getting coal or good wood; and, lastly, the enormous expense of erecting and maintaining a copper works. This paper is written for the use of those who have no such advantage (I mean the advantage of a well-appointed and well-officered smelting works, with plenty of work to keep it going, and other favourable conditions); and most particularly addressed to those who possess large bodies of ore, too poor to pay by the ordinary smelting process, or possessing some element of value that could not be rendered available by that process.

To have given this subject a proper value it would have been well to have endeavoured as far as possible to show the cost of applying each of the processes described. Such was my original intention, but several difficulties presented themselves, the principal of which was that in almost every case the materials used and labour employed varied in such a degree as to preclude the possibility of even an approximation; while any comparison of the kind would be open to challenge by the advocates of the rival systems. I must, therefore, content myself by stating generally that the smelting of copper ores, averaging 10 to 15 per cent., and of such character as to afford suitable fluxing mixtures, will cost for smelting with coal, at 2s. 6d. to 3s. per ton, about £15 to £16 per ton of refined copper produced; and with good wood, such as box, ironbark, and blue gum, readily procurable, about £20 to £25. It is not possible, however, to state what will be the cost of lime, iron, salt, chemicals, fireclay, or even fuel or labour, in any particular part of Australia, every individual case demanding separate study; and in the fact that different processes are adapted to different conditions lies what I conceive to be the whole value, if any, of this paper. If all conditions were alike, we could compare the value of the different processes, and elect which in our opinion possessed the greatest merit; but the fact is that they each possess independent merit; and where one would be a complete success under certain conditions, it would fail if these conditions were different. Precisely for these reasons the ingenuity of the chemist has been brought to bear to adapt processes where none previously known were available; and the necessity of the case has been the means of bringing a new process into being. Hitherto progress in copper-mining industry has been greatly retarded in this Colony, owing to that

bugbear, the smelting establishment; and men have been frightened even to ascertain what wealth they possessed, for fear of being induced to ruin themselves by turning smelters. Now, however, in the far interior—in places removed hundreds of miles from centres of civilization—any man possessing ordinary intelligence may commence by amusing himself with small experiments, having for his stock-in-trade in starting, a pick and shovel, a pestle and mortar, an iron kettle, a few tubs, and sufficient ingenuity to build himself a small furnace for roasting 100 lbs. weight of ore. He will want also a fair stock of determination not to be beaten until he has made a pound weight of cement copper; and after he has succeeded he will probably enlarge his work sufficiently to admit of the production of half a hundredweight of copper, and ultimately half a ton at a time. There are, no doubt, many who will break down at the first onset, and give it up; but I should be doing Australians an injustice did I not believe that many will persevere until they have mastered all obstacles.

No attempt has been made—and, indeed, it would be beyond the limits of this paper, to enter into minute details; but sufficient outline has been given to enable the earnest man of progress to supply the rest. The thirst for starting metallurgic work, on an inexpensive scale, is increasing, not only in this country, but in every country; but the avenues for obtaining preliminary information for making a start are few and insufficient.

In the preparation of this paper I have been encouraged by the hope that it will lead in many cases to experiments on a small scale, which will develop into industries of importance. This I shall esteem my best reward for any trouble I may have taken in directing attention to this subject.

ON SOME TERTIARY AUSTRALIAN POLYZOA.

By Rev. J. E. Tenison-Woods, F.G.S., F.L.S., Honorary Member Royal Society of N.S.W., Corr. Member Royal Society of Tasmania, and Linn. Society of N.S.W.

[*Read before the Royal Society of N.S.W.*, 4 *October*, 1876.]

The following fossils were, with one exception, derived from the Mount Gambier polyzoan limestones, S. Australia. They correspond with the Middle Cainozoic, and while showing a tertiary facies are very distinct from the existing fauna, which is the more remarkable as polyzoa generally have a large chronological range.

The fossil polyzoa of Australia have scarcely attracted any attention from naturalists; the only description known to me being that of Professor Busk, in the Geological Society's Journal, 1859, and a paper by myself in the Proc. Royal Society, Victoria, for 1862. The field is therefore almost an untrodden one. The corals (Alcyonaria, &c.) have been more fortunate, and, thanks to the zeal and industry of the learned President of the Geological Society, Dr. Duncan, all the known Australian tertiary corals have been described.

Eschara cavernosa, n.s. Fig. I.

Polyzoary, pedunculate, palmate; cells deeply immersed and concave, with a raised margin, aperture very large and round, sloping towards sides, giving a hood-like appearance in front, two large raised pores at base of each side of cell, others, however, when worn, have one large opening. Mount Gambier; rare.

Eschara porrecta, n.s. Fig. II, fig. III, single cell highly magnified.

Polyzoary, pedunculate, palmate; cells immersed, very long and slightly lozenge-shaped mouth raised towards summit, circular, slightly notched in front, with a sessile avicularium pore immediately below, another pore with a long channelled opening about the middle of the cell, the rest of the surface of which is irregularly reticulated with openings. Mount Gambier; rare.

Eschara Clarkei, n.s. Figs. IV, V, VI, worn specimens, differently magnified, fig. VII, single cell, highly magnified.

Polyzoary pedunculate, palmate, or multiform; cells immersed, pyriform, rounded on the summit and raised round the margin, obtusely carinate in front; orifice rounded above, contracted below and slightly crescentic, with a raised margin; mouth sloping downwards so as to leave only half the orifice visible in front; a pore for the avicularium upon the summit. Surface, covered with distinct equal-sized rounded granules. The worn specimens of this fossil vary very much, the margin of the mouth narrowing like a funnel or spread out over the cell; slightly worn species have the mouth continuous into a kind of groove upwards. It is the prevailing form at Hamilton, and is generally found there in large expanded masses. At Mount Gambier it also occurs, but in short stems; the cells are quite visible to the naked eye, which makes the species one of the very few Eschara which is attractive in its ordinary appearance as a fossil, without being magnified: Muddy Creek, Hamilton, Victoria.

I have dedicated this species to the Reverend Vice-President of the Society.

Eschara verrucosa, n.s. Fig. VIII.

Polyzoary expanded, cells arched with a raised spirally striated margin, surface covered with warty granules, the margin with pores, mouth crescentic and deeply immersed. Mount Gambier.

Eschara rustica, n.s. Fig. IX.

Polyzoary branched, cells slightly raised, and marked on each side with three pores, gradually increasing in size and terminating in a large pore with a raised margin; mouth oval and raised, with a pore on each side of the margin for avicularia; the first pair of pores round and indistinct, somewhat closer than the other; second pair, round and deep; third pair much larger, oval and very deep; a sort of channel on each side of the raised terminal pore; the worn species have the mouth obliterated, and then look like rustic work in architecture. Mount Gambier; common.

Eschara elevata, n.s. (Monilifera?). Fig. X.

Polyzoary branched, cells raised and marked on each side with a linear series of pores, meeting at the apex of the cell; six or eight in each series; mouth simple, oval, and produced. Mount Gambier; rare.

This may perhaps be a worn species of *E. monilifera.*—Busk.

ESCHARA LIVERSIDGEI, n.s. Fig. XI, nat. size; fig. XII, magnified; fig. XIII, highly magnified.

Polyzoary expanded, cells obscure, mouth rounded above, expanded below, underneath three large pores disposed in a triangle, or two above and one below; on each side of the lower one obscure pores may be traced; lower lip of orifice with a narrow sinus. Mount Gambier; not common.

I have dedicated this species to your Secretary, the learned Professor of Mineralogy.

ESCHARA OCULATA, n.s. Fig. XIV.

Polyzoary expanded or dichotomously branched, cells much raised, subtubular, and covered with irregularly-shaped pores of various sizes disposed unsymmetrically; mouth circular, simple. The irregularity on the pores of this species makes it difficult to recognize if it is at all worn. In the old specimens they coalesce and look like mouths, in the younger species it appears as if there were always three oval pores radiating symmetrically from the mouth. Mount Gambier; common.

ESCHARA TATEI, n.s. Fig. XV.

Polyzoary dichotomously marked with elongated cells surrounded by a raised margin, which is expanded above, and slightly concave about the mouth; two rows of pores with four or five in each; mouth round, with a raised margin, which is sinuated below.

Observation.—This fossil when worn and the mouth obliterated shows only the raised margin of the cell with the pores enlarged, so as to form a kind of net-work in front. The pores sometimes join to form one row at the base of the cell if it is narrow, which, as the cells are crowded and not regularly quincuncial, is frequently the case.

This species I have dedicated to Professor Tate, of the Adelaide University.

ESCHARA BUSKII, n.s. Fig. XVI highly magnified, fig. XVII nat. size.

Polyzoary expanded, branched; the branches lobate, cells quincuncially arranged; mammillated so as to make a rounded raised margin to the cells, which gives the frond a warty appearance, very porous, with three larger pores on the inferior lip triangularly disposed, orifice round and immersed. A very common fossil at Mount Gambier.

I have named this species after Professor G. Busk, F.R.S., &c., the greatest living authority on Polyzoa, and almost, we may say, the founder of its classification.

Pustulipora ungulata, n.s.

Polyzoary cylindrical, dichotomously branched; cells very slightly projecting and disposed in circles at equal distances, longitudinal lines of cells of different circles spiral; transverse section shows six partitions rayed liked the spokes of a wheel. Common; Mount Gambier.

Tubulipora Gambierensis, n.s.

Polyzoary erect, adhering by a slender cylindrical root; cells dispersed on one side, but a few tubes sometimes opening behind near the margin; tubes simple, slightly recurved, long and crowded, distinctly traceable behind but faintly so in front; mouth simple, disposed in irregular spiral lines in front; when worn the mouths are very plain in lines almost encircling the cylindrical axis. Mount Gambier; not common.

Pustulipora corrugata, n.s.

Polyzoary cylindrical, branched or lobed in the thicker specimens; cells tubular, recurved, a very prominent irregularity disposed all round, and distant space between the cells corrugated or wrinkled. In what seems to be the older branches of this fossil the cells are much closer and more numerous, the corrugations on the interspace cannot be traced and the branches are terminated by congeries of sessile cells. Mount Gambier, limestone; very common.

Conclusion.—The publication of these fossils may serve to identify the beds in other localities. The zone itself, whether met at Mount Gambier, Narracoorte, Cape Otway, Portland, or Table Cape, Tasmania, is pretty constant in character, being one immense mass of foraminifera, polyzoa, with few broken shells, echini, teeth, &c., all showing a very deep sea deposit. It indicates probably the lowest depths of subsidence in our tertiary seas—and a depth of over 300 fathoms.

[Plates.]

TERTIARY AUSTRALIAN POLYZOA

Fig. I

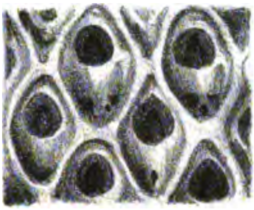


Fig. II

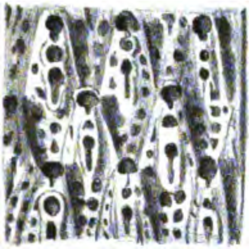


Fig. III

Fig. VI

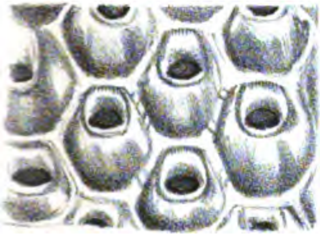


Fig. V

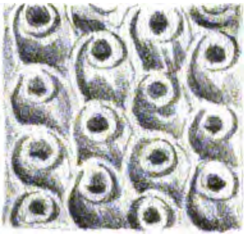


Fig. IV

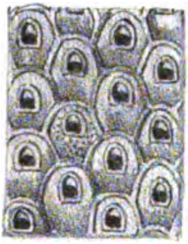


Fig. VII

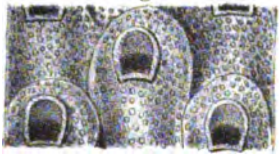
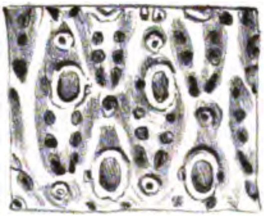


Fig. VIII

Fig. IX



WOODS. DEL.

ST LEIGH & Co LITH.

I. Eschara cavernosa
II & III. Eschara porrecta
IV. V. VI & VII. Eschara Clarkei

VIII. Eschara verrucosa
IX. Eschara rustica

TERTIARY AUSTRALIAN POLYZOA

Fig X

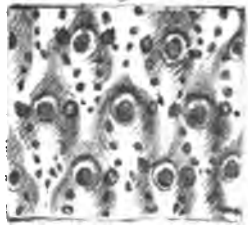


Fig XII

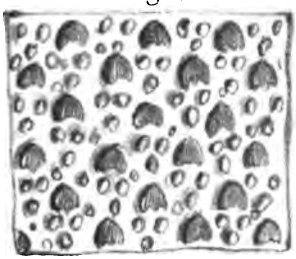


Fig XI

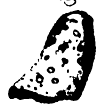


Fig XIII

Fig XIV

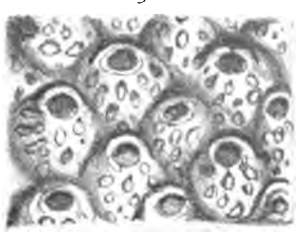


Fig. XV

Fig. XVI

Fig XVII

WOODS. DEL.

X. Eschara elevata (monilifera?) XV. Eschara Tatei
XI.XII & XIII. Eschara Liversidgei. XVI & XVII Eschara Buskii
XIV Eschara oculata n.s Syn E. oculata? Busk. Jour Geo Soc 1859

METEOROLOGICAL PERIODICITY.

By H. C. Russell, B.A., F.R.A.S., Government Astronomer.

[*Read before the Royal Society of N.S.W.*, 11 *October*, 1876.]

A popular writer has recently said—" Surely in meteorology, as in astronomy, the thing to hunt down is a cycle. If it is not found in the temperate zones, then go to the frigid zones or the torrid zone to look for it, and if found, above all things lay hold of it, record it, and see what it means. If there be no cycle, then despair for a time if you will, but yet plant firmly your science on a physical basis and wait for results." *

In the spirit of these remarks, I shall attempt to bring together some facts bearing upon meteorological cycles; but from the difficulty of obtaining detailed observations for long periods and for many places, I am obliged to confine what I have to say chiefly to Australia, though I hope to be able to show you that we are bound by the same meteorological causes which rule the northern hemisphere, except in so far as local peculiarities modify the weather, which results from cosmical causes.

On the general question, Is a meteorological period or cycle likely to be found? a great deal might be said both in favour of a affirmative, and also of a negative answer.

We know that the earth, year after year, revolves about the sun at an unvarying distance; that the sun changes declination, going north and south over the same range, and in the same time; that with it follow summer and winter, trade winds, monsoons, ocean currents, and a host of natural phenomena in regular succession. We know that the average temperature, barometric pressure, and winds are practically constant quantities; nay, if our lot be cast in some favoured climes we can tell to a day when the wind will change and the fruitful rain come with it, and we might say, with some appearance of truth, there is no cycle but an annual one.

But if we look a little deeper we find that our *averages* here, as in other things, are very apt to mislead us; and that under all this regularity there is much uncertainty. It is true that the sun makes his annual excursions north and south, but we find the trade wind going at times farther north and south—is strong or weak, is surrounded by hurricanes, rain storms, and danger, in

* Lockyer—Solar Physics.

what at first sight appears to us a most uncertain way. By and by two years of like character appear, and we dream of a cycle, and the comfort and value that a knowledge of the period, if there be one, would give us. We started this inquiry ages ago, and in the present day we have heard much about meteorological periods, their causes and effects; and we have learned, theoretically or practically, to take a deep interest in the subject; and the very difficulty of selecting the *true cycle*, or perhaps the convenience of having a number to choose from, so long as *our* facts may be represented, lends a charm to it.

To the certainty of one cycle and its undoubted cause we have all been accustomed to give our adherence, but the very familiarity with it often makes us fail to see that the cause which rules in the cycle of greatest changes, viz., from summer to winter, must surely be sufficient by its probable variation to produce the minor changes which distinguish one year from another. We know that a slight change in the sun's position in the sky is sufficient to make the difference between winter and summer; and yet, when one year differs from another, we seldom suspect the grand cause of any variation. We call in theories of heated plains, unusual rains, or winds, to our aid in explaining the phenomena, while, if questioned at another time as to the cause of the heated plains, or the action of interior continents, we should, without question, attribute them to the solar influence.

Passing, then, from the annual cycle, about which all are agreed, let us consider some of the "Periods" which have been put forward as the results of observation and investigation.

The shortest is that which for many years pleased meteorological observers in Tasmania, viz., two years—a wet and a dry one alternately. Such a period does not take long for its discovery, and is exceedingly convenient in many ways, but after some twenty or five-and-twenty years of regular recurrence, during which observers naturally thought it was fully proved and established, a change came, and two wet years appeared together—1848 and 1849—and these were followed by two dry ones. 1849, as we shall see, was a memorable year in the climate of New South Wales and the other Colonies, but here it was memorable as the dryest year on record. There it was the turning point in the *two years'* period; and Tasmania, like the other Colonies, has since had an uncertain rainfall.

The next "period" is one of three years, suggested here by my friend, Mr. Tebbutt, in the *Herald*, 27th February, 1874, and by him traced through all his observations at Windsor for a period of fourteen years. For these observations, and also for those of Sydney between 1863 and 1875, it agrees remarkably well with the results; but, in attempting to trace it back through

the Sydney and South Head observations, it fails to represent the rainfall results; very much, however, may be said in its favour, and it has been remarked also in the climate of Ceylon.

Mr. Tytler, writing in Ceylon on January 30, 1873, says:—"In the Tropics, at least here in Ceylon, where we enjoy the regular changes of the monsoons, the basic period runs five or six years dry and five or six years wet. These make eleven, and they form the medium cycle of *three years*, the grand cycle of thirty or thirty-three years being three periods of the eleven years cycle." It is evident, therefore, that in Ceylon some traces of a three-year period may be found.

Mr. Ranken, in his work on the Dominion of Australia, speaks of years of dry weather in Central Australia, followed by years of drought. Making "years of a season, and not seasons of a year," he thinks that the immense area of flat and heated plain has a cumulative effect upon the weather, making season after season dry, until the tension becomes too great, and a great inrush of polar wind takes place, bringing abundance of rain, which spreads all over the burnt-up plains. Once there, the water takes several years to get away. It rises, and is again precipitated, and flood after flood follows. He thinks that these changes over the vast extent of flat country in a large degree modifies the climate of its coast margins.

Of this view it may be said that two well-known facts appear to be overlooked. In the first place, the evaporation on those interior plains during the summer months must at least amount to 12 inches per month; and overhead is steadily blowing the return wind of the trades, which, as the moisture rises, sweeps it away to the south-east, to be precipitated far from the interior of Australia.

As we have already seen, a period of five or six years has been recognised in Ceylon; and although I am unable to trace it in our annual results, the monthly rain tables show some signs of it. For instance, in April, 1845, there was a very heavy fall of rain; again in 1850 and 1855, 1861, and 1867. Another series may be found in June, 1846; heavy rain in 1852, 1858, and 1864; but I do not think any weight can be attached to these. They are selected cases, and by no means represent the general character of the seasons.

A period, however, of between six and seven years may be traced in our dry years a long way back; thus: 1872, 1865, 1858, 1852, 1845, 1838, 1832, 1826, 1820, 1814, 1808; and it is, perhaps, worth remarking, the comet of Biela has a period of six and two-thirds years, and, whether connected with the cause of our seasons or not, has passed the earth in every one of these years except the three last, which should be 1819, 1813, and 1807, to agree with the comet's seven visits.

There are some who believe in a period of nine years, and no doubt facts might be brought forward if the period could only find a champion. Of the next period in our list a great deal has been said, and for many years amongst observers of this climate this period of ten years has been considered, if not an established fact, at least one on behalf of which very much could be said, and a large amount of experience brought in as evidence.

For instance, the series following may be taken:—

	1789, 1799	Dry years.
	1809	This year was certainly wet during the winter, but very dry during a part of it.
	1819	Wet year in the winter, but dry spring and beginning.
	1829, 1839, 1849	Very dry years.
	1859	Moderate year.
	1869	Latter half dry.
So	1808, 1818, 1828, 1838	Very dry years.
	1848	Wet, but dry spring.
	1858	Moderate.
	1868	Moderate.

And so of other series which might be taken, the ten years seem to bring round the same weather; and it will be observed that in the early days of the Colony it was far more marked than it has been during the last thirty years. It is not, therefore, surprising that those who had bitter experience of 1808, 1818, 1828, 1838, 1829, 1839, and 1849, should be convinced that a ten years' period was beyond question; yet, I think, a careful examination of all the evidence reveals so many exceptions that it cannot be looked upon as satisfactory, and it will presently be seen that these years are better represented by the nineteen years' period than by any other.

Mr. Symonds, in the Report of the British Association for 1865, and *Nature*, 1872, page 143, says:—"In a table I prepared for fifty years' rainfall in Great Britain, (1) the wettest years are 1836, 1841, 1848, 1852, and 1860; (2) that these, all but two, form a twelve-year period, viz., 1836, 1848, 1860, to which we may now add 1872; (3) that the dry years were 1826, 1834, 1844, 1854, 1855, 1858, and 1864; that of these, all but three form a ten-year period, viz., 1834, 1844, 1854, 1864. All this looked very satis-

factory; but to make assurance doubly sure, I determined to make up a longer period; this I accordingly did for 140 years, and I was so disappointed at the total disappearance of both ten and twelve-year periods that I cannot say that I have closely scrutinized the values herein given." Mr. Symonds is also inclined to adopt Mr. Meldrum's theory of wettest years with greatest sun spots.

But no period has found such general favour as that known as the sun-spots, or eleven-years period. Its advocates assert that meteorological phenomena vary as the area of spots on the sun's surface; that when they are at a maximum we have the maximum of hurricanes, violent storms, and rainfall. To Mr. Meldrum, of the Mauritius, belongs the honor of first pointing out the coincidence of these phenomena, not only for the Mauritius, but also for a large number of stations, so far as maximum rainfall is concerned; and it appears that out of the stations examined sixty-seven have the maximum rainfall between 1859 and 1862. Amongst these are included two of the Australian stations, Brisbane and Adelaide, which, to a certain extent, agree with this theory, while the other three Australian stations, where a long series of observations have been made, are left out. It is not stated whether the sixty-seven stations were selected, but the three Australian stations omitted do not agree with it, while the two that are taken, to a certain extent do agree. Speaking of these rainfall investigations, Mr. Lockyer grows warm, for he says:—"A most important cycle has been discovered, analogous in most respects to the saros discovered by the astronomers of old. Indeed, in more respects than one may the eleven-yearly period be called the saros of meteorology; and as the astronomers of old were profoundly ignorant of the true cause of the saros, so meteorologists of the present day are profoundly ignorant of the true nature of the connection between the sun and the earth." No doubt this theory has for a time met the growing feeling amongst students of this subject, viz., that we must look outside the earth for the true explanation of its irregular as well as its regular meteorological changes; but I do not think that we find in it the final answer. In the first place, the sun-spots period is not an eleven years period; it is generally called such, but if we examine records of the maxima and minima we find a very different result, for the period between maxima actually varies from seven to fifteen years, nay, it is itself subject to variations in intensity as well as in time; and there is much that indicates an unknown cycle in this phenomenon also.*

* Proctor has shown, page 188, "Science By-ways," that the sun-spot period cannot be traced in the earth's temperature, and the connection, if any, between it and rainfall and wind cannot, up to the present time, be considered proven, if indeed the evidence does not tend the other way.

In the next place, in the tropical limits of hurricanes, where the cycle is said to be most conspicuous, the truth of the theory has been denied by other observers, and I do not think that we can be satisfied with such an uncertain cause or coincident phenomena as the solution of our difficulty. It is true that the increase of sun-spots can be seen year by year, and to a certain extent the approach of a maximum can be detected in this way; but the sun-spot curve is a most irregular one—sometimes remaining almost stationary, and then, with a great outburst, running rapidly upwards. Besides, the great charm of a period is gone, if it may be seven or fifteen years long, as the case may be. For convenience I will here give the recorded dates of maxima and minima of sun-spots from "Loomis' Meteorology:"—

SUN-SPOT PERIODS.

Relative intensity.	Period.	Date of maxima.	Remarks.	Date of minima.	Period.	Remarks.
		Year.		Year.		
93	..	1778	Slight rise in curve—year 1781	1784	..	Rose nearly to max. by 1787.
111	11	1789	Rapid fall to 1791, then gradual	1798	14	Gradual rise.
73	15	1804	Quick fall to 1806, then gradual	1810	12	Slow rise.
44	12	1816	Gradual fall to 1820, then slow	1823	13	Steady rise until 1828, then slight fall, and again a rise.
58	14	1830	Quick fall	1833	10	Very rapid rise.
111	7	1837	Very quick fall to 1838, then quick fall.	1845	12	Rapid rise.
101	11	1848	Rapid fall to 1850, then a stop, and again a quick fall.	1856	11	Very rapid rise.
98	12	1860	Quick fall to 1863, then rise, and again quick fall.	1867	11	Very rapid rise.
140	10	1870	Rapid fall	....	..	——

The duration of this period has been variously stated as 11, 11¼, and 11⅓ years, with how much regard to observations we have already seen. Taking the rainfall at Sydney, 1860 had the greatest recorded rainfall here; but another year given as one of the limits of maximum, 1862, was, with one exception, the driest on record, while the nearest approach in rainfall here to 1860 was 1841, which was not a year of maximum or minimum sun-spots, but is exactly nineteen years from 1860.

Using our rainfall observations, as has been done in Mr. Meldrum's discussion of the results at other places—that is, taking three years together, one on each side of the maxima and minima, we get the following results:—

Minimum period	1843–44–45	... 195	inches of rain.
Maximum „	1847–48–49	... 115	„
Minimum „	1855–56–57	... 147	„

Maximum	period	1859–60–61 ...	183 inches of rain.
Minimum	„	1866–67–68 ...	140 „
Maximum	„	1869–70–71 ...	165 „

A period of twelve years has by some been thought to exist and be connected with Jupiter's revolution about the sun. No doubt this planet has a great influence on the solar system, and controls some of its meteor streams; but although I am fully prepared to admit the possibility of this action directly affecting our climate —and some confirmation appears to be found in such series as

1866	dry	or—	1865
1854			1853
1842			1829

(the intermediate year 1841 was very wet)—yet it fails altogether when extended to other series, and rainfall measurements show no trace of it. We are therefore compelled to feel, like Mr. Symonds, disappointment that it cannot be traced.

A period of thirteen years is said to be recognised by the majority of observers in Ceylon, and that the intensity of the monsoons, rainfall, and cloudy weather, vary in this cycle.

In America there are some indications of a period of seventeen years, and it is said that one of the marked features is the regular return of a plague of locusts.

In the British Association Report for 1842, page 24, Luke Howard, F.R.S., attempted to prove a period of eighteen years in the climate of England, from his own observations at Ackworth, in Yorkshire; but when he afterwards (1845) attempted to predict the weather on this theory, he stated that his lunar period was modified by the facts then taking place, and I am not aware that this period has been advocated by any one else.

The next period, "nineteen years," we will pass over for the present, to mention an opinion expressed by Mr. Jevons, whose valuable investigation into the climate of Australia gave him every facility for forming a correct estimate of our climate. He says (at page 81 of his work):—

"I think it will appear pretty plain from the table of floods and droughts that the history of the Australian Colonies comprehends only two complete and two incomplete climatic periods, thus):—

Period.	Commencing.	Terminating.	Characterised by
1. ...	—— ...	1798 ...	Drought
2. ...	1799 ...	1821 ...	Flood
3. ...	1822 ...	1841 ...	Drought
4. ...	1842 ...	Not terminated in 1858	Flood.

There can be no doubt that, taken as a whole, the second period, 1799 to 1821, was one of great floods; but 1808, 1810,

1813–14–15–16 will ever be remembered as years of severe drought. Again, 1822 to 1841, 1825, 1830, 1832, 1836 were wet years

Mr. Tytler, in Ceylon, lays great stress on the cycle which has been observed there for thirty years, and he points out that visitations of the horrible leeches of Ceylon and most of the great landslips occur at this interval, and that the Singalese, with their traditions going back some 2,000 years, believe in an Edorvore Kala and a Weyokala of thirty years or so.

Of longer periods we have not much to say, though an attempt has been made to establish a period of fifty-six years in England (5 times 11¼), and I shall have occasion further on to bring forward some facts which seem to point clearly to a long period of upwards of fifty years in this Colony.

In England Mr. Symonds's most valuable researches on the rainfall have revealed some very interesting facts upon which a paper could well be written, but I will here only mention one or two. In the middle of last century a very severe drought began in 1737, and between 1740 and 1750 the rainfall was nearly 30 per cent. below the average; after that it gradually rose to 1775, when five wet years, 1772 to 1776, came together, and such a wet period has not been experienced since; after this the rain curve sinks rapidly again to 1785, then a slight rise to 1795, then a fall to 1805, then a gradual rise to 1824, since which time there have been some very wet years, but the average keeps the rain curve nearly even. The *very* dry years were 1788, 1806, 1826, 1734, 1737-38, 1744, 1854, and 1864. These facts I have taken from Mr. Symonds's work, as they are valuable for comparison with some of our history and traditions derived from the aborigines, especially the *great drought*, of which more presently. (*See diagram at end of this paper.*)

Coming now to the period of nineteen years, which I think was first suggested in my "Notes on the Climate of New South Wales, 1870"; but as the history of cycle-hunting has not yet been written, it is impossible to say that it has never been observed or published before. It is, however, certain that it was then first detected in our rainfall observations; and, so far as the information was then available, it was traced back for two periods. The rainfall diagram from this point of view was then published, including the results from 1840 to 1869. The following year (1871), Professor Smith, in his opening address to the Royal Society of N.S.W., took up the subject, and added considerably to the information I had published. The information about many years in the list then available was very meagre; yet the evidence again seemed in its favour, as may be judged from the following numerical statement:—eighty-seven years were examined; of these fifty-two fell into the nineteen-year period, twenty-five years were *not determined* from want of information,

and ten appeared to be exceptions—that is, of the determined years only one in six was as an exception.

Since then I have been able, by a diligent search for information, to add largely to our knowledge of the meteorology of past years; and, whatever may become in after years of the nineteen-years period, it has more in its favour now than ever before. Experience, however, can alone decide this question, and I have never put the theory forward as the *solution* of our difficulty. The evidence has convinced me that it represents our climatic changes, but nothing will please me better than a succession of fine seasons from now onwards, in direct opposition to what the present investigation leads me to expect; for such seasons would be of infinitely more value than the confirmation of the theory could possibly be. And I think I shall be able to show you that there is an amount of probability in its favour that will justify at least a careful examination; for if it should prove true, there is warning of seasons to come which may, if rightly used, be of the greatest value to the grazier and the agriculturist. A page of figures is not generally enticing to the reader, and I have, therefore, put into the form of curves the rainfall at each place from year to year, and for convenience they have been arranged, as Sydney curve is, in the nineteen-years period. It is, however, impossible to convey in this way an exact idea of the character of each year, for the curve is in some cases wholly distorted by rainstorms, as for instance, in 1844, where the curve is raised twenty inches by the rain-storm of one day; and again in 1868, a very dry year and counterpart of 1849, we have a rain-storm in February in which ten inches fell. So again of 1870, it was the excessive rain in March that masked the drought of six months of the year; but a very good general idea is obtained, and it seems, in my opinion, to illustrate the theory that we have every nineteen years a recurrence of similar weather. We have already seen that much may be said in favour of a nine or ten years period, that is about half the period indicated, and there is doubtless this sub-period which for three or four turns seems to fall in with the facts; but if we attempt to carry it through all the years it wholly fails. While tracing the nineteen years period through past history, we find no less than eleven well-marked lines in the series, and in many of them special characteristics will be found reproduced step after step in the series.

The second set of curves represents the rainfall at other places in Australia, and one station (Greenwich) from the northern hemisphere, which is put in for comparison; and although the theory does not at first sight seem borne out by the Greenwich curve, yet there are remarkable coincidences in the character of the curves, if they are viewed in the light of remarks to be made presently.

It will be seen that the Brisbane rain curve follows Sydney very well; it is below the average in 1859, above it for the two years 1860–61, very low in 1862, high again in 1863–4, very low in our memorable 1865, and so on, running to maxima in 1870 and 1873, like the rain curve at Sydney. Melbourne is sometimes with Sydney, as in 1862, 1865, 1868, and 1870, when droughts or heavy rains involved the whole eastern coasts; but it often accords with the Adelaide curve, to which I wish to draw your particular attention, as it bears strongly on the opinions expressed in this paper. (*Diagram* 1).

The Adelaide curve, if *inverted*, agrees very closely with that for Sydney, or, in other words, their rain seasons are the opposite of ours; and when the dry seasons prevail here, the rain precipitation, as I have before stated, is pushed southward, and recorded in Adelaide, and often in Melbourne. From 1840 to 1859 this fact is most striking, and, excepting 1854, 1864, and 1869, when, as before stated, droughts seemed to envelope the whole of Australia, we have a very marked agreement. For the first nineteen years, seventeen are the reverse of Sydney, two agree with it; for the second period, eight out of fourteen are the reverse of Sydney, and the others indifferent; so that, twenty-five years out of thirty-three, the rain curve at Adelaide is the reverse of Sydney. At Melbourne these phenomena are not so marked; but in many cases the same may be observed, notably of our driest year. 1849; it was at Melbourne the wettest on record.

The remarks just made form a very good illustration of what I have to state presently, viz., that the same cause, even a distant one, will not produce the same effects on different portions of the earth's surface. The force that brings us a drought usually carries rain in abundance to South Australia.

Let us now take the years in series, as they are arranged in the diagrams, only remarking that the year 1783 to 1787 are with us pre-historic:—

1802. A medium year, but there is little information.
1821. Moderate rain in July; heavy rain and floods in September.
1840. Moderate rains; heavy in July and September.
1859. Heavy rain in January and February; rain in July; very heavy and flood in September.

1803. Early part, very dry; latter part, wet and favourable.
1822. Early part, very dry; abundant rain in February; latter part, wet.
1841. February, dry; terrific rain in April 29; abundant rains latter part.

1860. Early part, wet; very heavy rain, April 28 and 29; abundant rains latter part.

1804. Heavy rain, April and October; moderate year.
1823. Heavy rain, March and October; moderate year.
1842. Moderate year; heavy rain, February; June, October, and November, dry months.
1861. Heavy rain, April and August; September to end of year, dry.

1805. Wet; floods in Hawkesbury and South Creek, March, October, and November.
1824. Wet; heavy rains, July, September, and October; Murrumbidgee in high flood, 20th, 21st, and 22nd October.
1843. Wet; very heavy rains, February, March, April, and August.
1862. Dry; heavy rain, February; rest of year very dry.

1787. Wet (?); when the colonists landed they saw recent flood-marks.
1806. Wet; very high flood in March; flood in October.
1825. Wet; abundant rains in March; floods in August.
1844. Wet; flood rains in June, and heavier in October.
1863. Wet; January, February, and March, very heavy rain; also August, and for sixteen days in October.

1788. Wet; heavy rain, February and August; October, November, dry.
1807. Wet; heavy rain and flood, January; wet in June; (no information end).
1826. Wet; heavy rain and flood, January; floods in August; September, October, November, dry.
1845. Wet; heavy rain, January and February; flood rains in April; August, September, and October, dry.
1864. Wet; heavy rain, February and March; high flood in June; September and November, dry.

1789. Dry; "the colonists suffered a parching thirst for several months."
1808. Dry; year very dry, but flood in November.
1827. Dry; dry year; heavy rain in April; little information to be had.
1846. Dry; dry year; heavy rain in November.
1865. Dry; dry year; heavy rain in November.
1790. Dry; February and March, heavy rain; *no rain* June to November.

1809. Dry; February and March, heavy rain; floods, May and July; rest of year very dry.
1828. Dry; April and June, heavy rain; end of year hot and dry.
1847. Dry; January, April, and May, heavy rain; latter part of year very dry.
1866. Dry; January, February, heavy rain; floods in June and July; August to end, dry.

1791. Early part severe drought; (end no information).
1810. Early part severe drought; tanks dry in February; flood in July.
1829. Early part drought; heavy rain, May and August; flood in November.
1848. Early part wet; February, April, May, dry; flood rains, July and October; end dry.
1867. January, February, dry; March, April, very wet; June, highest flood on record; end dry.

1792. Dry; heavy rain, April and September.
1811. Dry; early part dry; Sydney tanks dry for weeks in February; flood in March.
1830. Rain in January; floods, March and April; floods in October and November.
1849. Dry; early part very dry; heavy rain, May and July; end very dry.
1868. Dry; January and February, wet; March and April, very dry; May and July, heavy rain; end dry.

1793. Early part dry; rain in April and May.
1812. Early part dry; heavy rain in March; floods in November.
1831. Early part dry; floods in April and May; rain in November.
1850. Early part dry; heavy rain, March and April; flood rains, July and October.
1869. Early part dry; February and March, heavy rain; flood in May; heavy rain in November.

1794. Moderate year; very wet August.
1813. Dry weather; heavy rains in October.
1832. Early part dry; heavy rains in March and April; May, June, July, very dry; rain in August.
1851. Early part dry; heavy rain, February and April; May to September, dry; rain, October.
1870. Early part dry; March and May, heavy rain; June to September, very dry; rain, October and November.

1795. Dry; floods in January; March, wet; very heavy rain in August.
1814. Dry; rains early in April; early spring drought; rain in October.
1833. Dry; rains, February and March; spring drought; rain in September.
1852. Dry; March, rains; June, heavy rain; July, October, and December, dry; rain in August and November.
1871. Dry; March, May, and June, wet; July, October, December, dry; rain in August.

1796. Early part, no information; floods in August; wet in December.
1815. Very dry; rain in August and December.
1834. Early part dry (water scarce in Sydney); rain in August.
1853. February and April, very dry; heavy rain, July and August; September, October, and December, dry.
1872. February and April, dry; dry winter; rain in August and December.

1797. January, very hot; March and April, wet; May, June, July, very dry.
1816. No information; February, wet; high floods, May 30 and June 20; dry spring.
1835. January, very hot; March, wet; very dry winter; July, rain; dry spring.
1854. January, hot; rain, March, April, and June; very dry all the rest of year.
1873. January, hot; February, great flood; floods on the 5th and 18th June; August, September, October, dry.

1798. January and March, heavy rain; May, wet; very dry spring.
1817. January and March, heavy rains; May, wet; (no information).
1836. February and March, heavy rain; May, wet; snow in Sydney, June; cold, dry spring.
1855. February, March, April, wet; winter, very cold; dry, cold spring.
1874. February to July, very wet; winter, very cold; August, September, dry.

1799. Dry; January and February, hot and dry; floods in March.
1818. Dry; no information; floods in March; dry spring; rain, September.

1837. Dry; February, hot and dry; heavy rains, March; September to end of year, dry.
1856. Dry; March, April, May, heavy rains; very dry spring.
1875. Dry; floods in March; wet in April, May, and June; July to end, very dry.

1800. Early part dry; March, heavy rain and flood; seems to have had dry spring.
1819. Early part dry; February, March, and June, floods; dry spring; summer very dry.
1838. Early part dry; March and April, rain; dry spring; storm and rain, 10th and 13th October; 2nd November, day of humiliation on account of drought.
1857. Early part dry; February, March, and April, wet; September, November, December, dry; storm and rain, 6th and 7th October.
1876. Early part dry; April and May, wet; storm and rain, 7th and 8th October. For the remainder of this year we have yet to write the history.*

1801. A very high flood in March is the only information yet found.
1820. Summer very dry; Sydney water all gone, except in wells; floods in June and July; August, September, October, and November, very dry; heavy rain in December.
1839. Summer very dry; heavy rain in April; dry spring; rain in October.
1858. Summer very dry; heavy rain, April and May; very dry, July, August, September, November, and December; rain in October.
1877. The character of this year we have yet to learn, but the series in which it stands has been very dry from the beginning.

Bearing in mind that in this period it is supposed that the general character of the weather returns, and that it is only in some of the series that well-marked characters develop themselves, it is interesting to look back and see how the question of probability stands numerically, ninety years are under consideration; of these there are only three, 1830–48–62, that are decided exceptions. I do not mean to say that there will be the same wet or the same amount of dry weather in every year of a series, but that the general character of the years in each series will be the same; in one year, for instance, 1870, there may be an excessive fall of rain for two or three months, but take the year through, and it will be found very dry at the beginning; a wet

* Moderate rain fell in October 1876 along the Mountain and Coast district, but it was still very dry in far west. In November moderate rain fell generally over the Colony, but the weather was very hot. In December no rain, 1st to 12th.

autumn, a dry spring, and then rain in the early summer, like other years in the series.

The droughts also show themselves very remarkably—1865–6, 1846–7, 1827-8, 1808-1809, 1789-1790.

So, of the well-known three years drought, it appears first in 1799, 1800, 1801; in 1818, 1819, 1820; in 1837, 38, 39; in 1856, 57, 58; and lastly in 1875, 1876; of 1877 we have yet to learn the character. In 1819 there were some very severe floods, and so in 1876 have we had similar heavy floods in some parts of the country, and so the great floods of 1809 find their representatives in 1866, fifty-seven years afterwards.*

Heavy floods are not always an indication of a wet year, very often they come in droughts, and naturally follow the great disturbances which then take place between the polar and equatorial currents; moreover, our rivers are so situated with respect to the mountains, that a heavy thunderstorm may make a flood, and in proof of this it may be stated that the first flood that ever alarmed the Hawkesbury settlers in 1799 came down on them without even an appearance of rain preceding it.

In looking at these droughts which are recorded, it is worth while to notice one or two of the traditions of the blacks. When Singleton was first settled, in 1821, the aborigines told the settlers that long before, there was a fearful drought, in which all the lower part of the Hunter River dried up, and the only place they could obtain water was at the head of the river, amongst the mountain springs; that here all the tribes—even those who bore each other the greatest enmity—collected, and for sake of dear life lived peaceably for the time. Still the drought dragged on. All the great gum-trees died, and vast numbers of the blacks, who were buried by their friends in a great field. In proof of these statements, the graves and dead trees still standing in 1822 were shown to the whites.† We may here recall

* Droughts are a much more marked feature of climate than floods, for floods are often the product of a great storm, and some of the greatest have come in notably dry years. Even in the fearfully dry year 1862 there was very heavy rain in February, and in 1865, a memorable year of drought, 9·877 in. fell in November, and of this 4 inches fell in one day. So in June, 1866, 3 inches fell on the 15th; so of 1849, 5·610 in. fell in May, and of this 2·640 in. fell in one day.

† In confirmation of the tradition of the blacks, it may be mentioned that a keen observer, who was sent by Captain King from Sydney to Melbourne along the coast, in 1802, says—"All the *great* gum trees were dead in every place I visited, and especially on Elephant Island, here I saw enormous dead trees, 5 to 6 feet in diameter, surrounded by a dense forest of young trees from 6 to 18 inches in diameter, these were only two or three feet apart, while of the old big trees there were only about twenty to the acre." The young trees were just such a growth as might be expected in that rich soil in the forty or fifty years which had probably elapsed since the great drought.

the fearful drought extending over many years, in the middle of the 18th century (1740 to 1750), as shown in Mr. Symonds's work; and we may mention that the drought of 1789 has its counterpart in England in 1788; that of 1814-15 here, in 1813-14 there; that of 1827 here, in 1826 there; that of 1837-38 here, in 1837-38 there; that of 1846-47 here, in 1844-45 there. Many other instances might be given, but these are enough. (*See diagram*).

In Africa, Livingstone records the drought of 1846-7 as follows:—

("South Africa," pages 17 and 18.)

"During the first year of our residence at Chonuane (1845) we were visited by one of those droughts which occur from time to time in even the most favoured districts of Africa.

"In the second year (1846) scarce any rain fell; the third was marked by the same extraordinary drought, and during these two years the whole rainfall did not amount to 10 inches. The Kolobeng ran dry, and so many fish died that the hyenas from the country collected to the feast and were unable to clear away the putrid mass. A large old alligator was left high and dry in the mud among the victims. The fourth year, 1848, was equally unpropitious, the rain being insufficient to bring the grain to maturity; needles lying out of doors for months did not rust; and a mixture of sulphuric acid and water, used in a galvanic battery, parted with all its moisture to the air, instead of imbibing more from the atmosphere, as it would have done in England. I put the bulb of a thermometer three inches under the soil in the sun at mid-day, and found that the temperature was from 132° to 134°. Rain would not fall, and dew there was none."

Again, in India we have 1837 standing out as their most dreadful year of drought and famine.*

Surely we have here enough to justify a strong suspicion, to say no more, that we have waves of drought passing over the earth, that we have an outside cause for the phenomena that has puzzled us so long—a phenomenon which we have every reason to believe is subject to laws as definite as those which hold the planets in their places, and the knowledge of which is fairly within our reach, if we have but patience to take the uphill way that leads to it. Nor must we at once assume that, if a period is proven at one place, we shall find the same at another. There is, I think, unmistakeable evidence of several involved periods; out of the combination of these with local circumstances come the results there observed; like the vibrations in musical notes,

* In 1872 rain almost deserted Bengal, and fell in great quantity in Northern India, while the rainfall of 1873 was the lowest on record, with the single exception of 1837; and 1862, the very dry year in Sydney, was also a year of drought in Central Russia.

they will "beat" just in accordance with the conditions existing. For instance, with one of the waves of drought we may have the conditions which shift the trade winds and send a comparatively plentiful rainfall; or we may have a number of forces at work which shall make the nineteen years cycle of one place the thirty years period of another.

As bearing upon this question, the history of Lake George is instructive, situated as it is in the mountains, with a well-defined catchment area, and no outlet. It forms a sort of natural rain-gauge, and should afford valuable information. I have been at some trouble to learn its history. In the latter part of 1820 it was discovered, and was then a magnificent sheet of water; but, fine as it appeared, the blacks declared they had seen it dry, and even covered by a forest—tales that looked, at the time, very improbable. The heavy rains of 1821 and 1822 filled it up considerably above what had been its level for many years, for it killed a great number of gum-trees round its margin, many of which were two feet in diameter. In 1824 it was twenty miles long, and about eight miles wide; from 1826 the water gradually dried up, and during the drought of 1827, 1828, 1829, its size got rapidly less; in 1828 it was fifteen miles long. In 1832 it was possible to ride over it, and it appears to have been dry, or nearly dry, from Kenny's Point to George's Gap. In 1836 it was visited by Sir Thomas Mitchell, and by him described as a grassy meadow like Breadalbane Plains, with dead timber on it. From this time it became a cattle and sheep run, at times having some water in it, which soon dried up. In 1842 and 1843, water accumulated; but in 1846 and 1847 it got quite dry again, and it was not until the floods of 1852 that any large quantity of water stayed in it. In the drought of 1866 and 1868 the water nearly all disappeared; but from 1870 it steadily increased, and by August, 1874, it was higher than ever before known, and again killed a number of trees around its margin. The water is now gradually decreasing (1876). It is therefore evident that from 1825 the lake decreased in size, and though sometimes of moderate extent after heavy rains, it soon dried up, and it was not until 1870 that the lake showed such decided signs of increase, rising to its maximum in 1874. It is difficult, nay impossible, to say in what years the lake filled up before, but judging from the seasons, it is very probable that it began to fill in 1816 and 1817, finding its maximum about 1822. Looking back at the droughts which came before these rains, it is most likely the lake was more or less dry from 1790 to 1800, and at that time afforded the experience related by the blacks in 1820; but taking only these points which are historical, we have the lake at its maximum in 1824 and in 1874, a period of fifty years.

On the Hunter River, about West Maitland, in the early days of the settlement, there were evidences of comparatively

recent encroachments on the south or town side, and on the opposite side a considerable portion of land had been left by the river, the current setting strongly on the town side; but the water in an ana-branch still surrounding the portion that had been left, flood after flood came great and small, and deposited mud, till the ana-branch was filled up, but no decided change came in the river's course, even in the greatest floods of 1857 and others, until 1870, when all at once, as it were, the river began to cut in on the town, and took away whole houses, even a terrace of small ones, and seemed disposed to cut off a large bend in the river, and many acres of the town, at the same time it made another large addition to the opposite side at that point, entirely changing its course. Judging from the great floods in the Hawkesbury in 1816 to 1819, it is probable that the Hunter was similarly visited; indeed, there was debris in the trees at the first settlement which left no doubt of the fact, and we are left to form an opinion of the date from the recent character of the debris, and the banks of the river where changes had taken place; and I do not think we can, from the known character of the seasons, place them at any other date than about 1817; or, in other words, we have evidence here of a similar period to that observed in Lake George; and it is interesting, in connection with the general evidence from Lake George and the Hunter of a long period during which the seasons seem to run to a climax, to note some of the facts in connection with the nineteen-year period, which seem to me to prove beyond doubt that there is a tendency here also to run at every third period to a maximum. To take the whole of the evidence on this subject which may be derived from the tabular statements would take much too long for our present purpose, and a few instances will be sufficient to show that this tendency exists, which is all I wish to do at present:—

1790. There was heavy rain in February and March, and it is said, "no rain fell from June to November," which was a very severe drought.

1847. There were heavy rains in the early part of the year, but from May to the end of the year was a very severe drought.

Again, 1809, one of the intermediate years, while generally a dry year, and specially so at the end, had very heavy rains in May and July, and in the latter month a very heavy flood.

While 1866, a similar year, and, like 1809, very dry at the end, had heavy floods in June and July.

The other year of this series, 1828, there was heavy rain in April and June, and a very hot and dry spring. We have yet to learn if that fearful drought, so well known of old, will reappear in 1885.

Or, taking another line of the nineteen years series:—

1797. January was very hot, March and April wet, and from May to the end of the year very dry.

1854. January, hot; March, April, and June wet; all the rest of the year very dry. Of the intermediate year, 1816, though there was, like these, a dry spring, there were very high floods, May 30 and June 20, and heavy rain in November.

While 1873, the fifty-seventh year from 1816, there were floods on the 5th and 18th June, almost returning to the day, and there was a dry spring.

It is needless to multiply instances—pages might be filled had we the time; those which have been given are sufficient to establish a very strong probability in favour of this law. To others, who have not investigated the facts, it may come with less force than it does to me; but those who are interested will shortly have before them more complete information about the meteorology of New South Wales for past years than it is possible to give in this paper.

Of the probable cause or causes which produce the effects we have been considering, volumes might be written; but space requires me to condense into a few pages my views on this subject; and, at the risk of leaving out some points of importance, I will try to be as brief as possible.

And first, allow me to say, that I still hold the opinion (which was expressed in my "Notes on the Climate of New South Wales" in 1870), viz., that it is wet or dry with us, just as the trade winds are weaker or stronger. In other words, that when from *some cause* the trade winds and N.W. monsoon set to the southward with more force than usual, we have a preponderance of northerly and north-westerly winds, and, of course, dry weather, because the region of rain precipitation is on the margin of the trades; and if this is pushed to the south of us, we have dry winds here, and an extra rainfall on the south coast; and if the trade wind is weaker we are in the rain region and have abundance of it; and I have by no means given up the opinion expressed at the same time, that the moon has a great influence upon our weather. Every year only adds to the facts which, to me at least, prove lunar influence on the weather; and had I time I should be glad to introduce here many of them from my own observation which go to prove the moon's influence in *forming* and in *dissipating* clouds, besides many collateral facts proving her influence on the atmosphere, volcanoes, &c., but these must be left for another opportunity.

Since 1870 many facts bearing upon the interdependence of the parts of the solar system have been brought to light, more especially by the study of meteoric astronomy, which seem to

throw light on many historical statements, and phenomena that have been observed in more recent times—phenomena which I I think a little consideration will convince us could not take place without producing very decided effects upon the earth's atmosphere.

It has been proved that the number of meteor streams is almost inconceivable; that they revolve about the sun at all degrees of inclination to the ecliptic, and in all sorts of periods; that many of them have their perihelion within the earth's orbit; and that in the meteor rings there is not a uniform distribution of the matter composing it, as has been shown by Professor Newton. With regard to comets also, facts seem to prove that they are not uniformly distributed in space, the sun in his onward course meeting more at one time than at another. "From 1600 to 1750 (150 years), only sixteen comets were visible to the naked eye; of these, eight appeared in twenty-five years (1664 to 1689); and during the sixty years (1750 to 1810) only five comets were visible to the naked eye, while in the next fifty years there were double that number."—(" Kirkwood.")

From these known conditions we should expect that at times the earth would pass regions of greater meteoric density, in which the denser portions of meteor rings happened to come together; in this way, in all probability, so much matter intervenes between the earth and sun that his heating power is temporarily much reduced.* And every one who has watched the sun's heating power knows that it varies enormously, and the sun-spots do not seem to affect it. When these changes are observed in the solar radiation, all that can be seen with the telescope directed to the sun is a troublesome thickness and confusion in the air that is a bar to all delicate observations. At night the same thickness in the air may often be detected, and it reveals itself to the naked eye as a phosphorescent or milky appearance in what should otherwise be a black sky.

It is amongst these phenomena, the laws of which are daily

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* And observation proves this to be fact, for whenever the sun has been seen in total eclipses its envelope has had a most irregular form, generally radiated. At times the corona, as in December, 1870, extended round 180° of the sun's circumference, while the other 180° was divided into three irregular rays by dark spaces which extended nearly to the sun's limb; or again, as in 1868, forming no less than nine rays extending from the sun to an immense distance into space. In 1870, photography proved that the corona extended for nearly double the sun's diameter on one side, while at another place the extent was only one-eighth of this, and it is evident that matter which is capable of reflecting light and heat must be also sufficient to prevent some of the radiation from the sun, and, as Proctor justly remarks, "Science By-ways," page 161, "no reasonable doubt can exist that the matter (forming the solar corona) is no other than the meteoric and cometic matter which other researches have taught us to recognise as plentifully strewn throughout the regions around the sun."

being brought more within our reach, that I think we must look for the causes which produce the proverbial uncertainty of the weather—an uncertainty which will doubtless disappear when we shall have learned more about the smaller elements of the solar system.

Here also we shall find an explanation of the dependence of the seasons of the two hemispheres, and the reason why a remarkable season in the north may be followed by a similar one in the south, or *vice versa.* For the causes of which we have been speaking may last days or months, and in the latter case would have a similar effect upon both hemispheres; but if the duration is short, the similarity in effect would probably not be noticed, for a very clear ether and increased solar effects would have different results in an Australian summer and an English winter.

In this view of our subject it will be interesting to refer to opinions which have been expressed by others. A well-marked depression in temperature has been observed in Europe in the months of February and May, and the celebrated M. Erman considered that "this is caused by the interposition of meteoric rings between us and the sun, and that the increase in temperature in August and November is caused by their preventing radiation from our globe, and possibly by radiation towards us of a part of the heat which they themselves receive;" and a "French physicist, M. Deville, who has examined in the most crucial manner the temperatures of the months of August and November since 1808, has detected the fact that in both months there is an increase of temperature about the period of the star showers, and a decrease in February and May, which he does not hesitate to ascribe to the influence of meteoric rings." (Guilemin, Ast.)

It may be mentioned that the 10th of August meteor stream, if disposed in the form of a flat ring, would encounter the ecliptic between the 5th and 11th of February, and would partially eclipse the sun's light.

As the data upon which these views were founded were for the northern hemisphere, it is interesting to inquire if any similar phenomena have presented themselves here; and, comparatively short as the time of our observations has been, we get several marked instances, and in every year examined there is a depression in the temperature curve between the 5th and 11th of February, and in nearly all cases it is on the 8th, 9th, or 10th.

In 1869 there is a marked fall in the annual temperature curve in February, although during February there was less cloud and cool south wind than in March and January. In the temperature curve for that month there is a great depression on the 10th, and on the nights of the 10th and 11th there were terrific cyclonic storms, with thunder and lightning, in Sydney.

In 1868 also there was a great fall in the temperature in February, and the average for the month was only equal to that of March.

In 1860, February temperature is again below January and March, and there was less south wind in February than in either of the other months. On the 9th, 10th, and 11th there were storms of thunder, lightning, and heavy rain.

Other remarkable depressions in the temperature of other months might be given of the same kind, but these will suffice of particular instances.

No one can, I think, look at the temperature curve plotted for a number of years without being struck by its strange anomalies. One year the temperature runs up suddenly to its maximum, and one month, or part of it, constitutes the summer; while in another year it rises to the same temperature and retains it for two or three months, the temperature of each being quite as high as the year of short summer. It is the same in winter. The curve is pointed, or rounded, in direct accordance with the circumstances which modify the sun's heating power. That these are between us and the sun does not, I conceive, admit of a doubt. Year after year the sun rolls on, and the spots which we see on his surface do not sem to affect his heating power, or if they do, almost inappreciably; while month after month, or season after season, strange irregular changes take place in the temperature, which can only be accounted for on the supposition that space between the sun and earth is not empty. To what extent these cosmical causes may interfere may be judged from historical statements.

Humboldt remarks with regard to the occasional darkening of the sun, that "a phenomenon of this kind, which cannot be explained by fogs or volcanic ashes, occurred in the year 1547 (24th to 28th August), and lasted three days. The sun was reddish, and so dark that several stars were visible at noonday" Similar darkenings of the sun's surface occurred in 1090 and 1208, but lasted for a shorter time—the former for three hours and the latter for six hours. Messier states that on the 17th June, 1777, about noon, he perceived an immense number of black globules pass over the sun's disc. Two other obscurations of the sun, that of the beginning of February, 1106, and that of 12th of May, 1706, during which, about 10 o'clock in the morning, it became so dark that bats commenced flying, and persons were obliged to light candles, do not appear to admit of any other explanation.

One other case from Roman history may be mentioned:—"At certain times the sun appears to be not of his wonted brightness, as it happened to be for a whole year when Cæsar was murdered, when it was so darkened that it could not ripen the fruits of the earth."—*Virgil*, Geor., Liber 1, &c.

Dr. Weiss of Vienna, says:—"Cosmical clouds undoubtedly appear in the universe, but only of such density that in most cases they possess sufficient coherence to withstand the destructive operation of the sun's attraction, not only up to the boundaries of our system, but even within it."

He considers that comets from these clouds, when the earth meets them, give ocular demonstration of the fact in a shower of meteors; and on the 27th of November, 1872, when the earth passed over the orbit of Biela's comet, such a shower actually took place, and a magnificent display of meteors was seen. At Turin, 33,400 were observed in 6½ hours; and in other places similar displays were seen; and if to these recorded meteors we add the far greater number that were not seen, we get some idea of the density of this stream representing only a faint comet, and how potent a cause for effects on terrestrial temperature may exist between the earth and the sun, all unheeded by us.

I confess that the account given of the darkening and red colour of the sun during a whole year does not seem to me so incredible as many have esteemed it; for we have in modern times two accounts of a similar phenomenon, lasting for weeks, viz., the *dry fogs* of 1783 and 1831. Many have attributed these to the action of volcanoes, and it is well known that in 1783 the fearful earthquakes in Calabria took place in February, and began a long list of volcanic eruption in the world; but in estimating the part played by volcanoes in these and similar phenomena, it is to be borne in mind that there must be a cause for the volcanic outbreak, and probably a cosmical one. Modern research has shown that they are subject to tidal effects like the ocean, or to distant attractive forces, and that eruptions are not caused by contraction of the earth's surface *only*, but by this and some other forces combined.

Besides, if great volcanic eruptions produced these dry fogs, we should have had many recorded in the world's history, and the peculiar and disagreeable smell would have been recognised; probably, also, rain would have thrown them down.

On the other hand, dust has been collected on the high snow-covered mountains, and when examined it proved to be meteoric dust.

Of the dry fog which came on suddenly in June, 1873, it is recorded that it extended from the northern coasts of Africa, over France, to Sweden, and over great part of North America, and lasted more than a month. Travellers found it on the summits of the Alps. Abundant rains in June and July, and most violent winds did not dissipate it; and, in some places, it was so dense that the sun could not be seen until it had attained an altitude of twelve degrees, and throughout the daytime it was red and so dull that it might be looked at with the naked eye. The fog

diffused a disagreeable odour, and the humidity ranged from 57 to 68, while in an ordinary fog it is 100. It had a phosphorescent appearance, and the light at midnight was compared to that of the full moon. The second instance :—

The extraordinary fog of 1831 excited public attention in the four quarters of the world. It appeared on the

Coast of Africa	August 3.
At Odessa........................	August 9.
In South France	August 10.
Paris	August 10.
New York.......................	August 15.
Canton (China)	End of August.

This fog was so thick that it was possible to observe the sun all day with the naked eye, and without a dark glass, and in some places the sun could not be seen till it was 15° or 20° high. At Algiers, United States, and Canton, the sun's disc appeared of an azure blue or of a greenish colour. Where the fog was dense, the smallest print could be read even at midnight.

M. Arago, the great French astronomer, was at some trouble to prove that these fogs could not be comets, and gave as his principal reason that it would be impossible for the head of the comet to rise and set with the sun for more than a month, which is quite true; but it is nevertheless possible that the comet left part of his tail with the earth, while the head was too insignificant to be seen.

I will not stay to point out the bearing of these facts on the opinions previously expressed, for this paper is already too long A wide field for speculation is opened up when we look at some of the facts which have been brought forward to-night; and I think enough has been said to convince us that, in discussing the meteorology of the past or the future, we must ever bear in mind that the solar system is not stationary—it is rolling on into the unknown regions of space. What changes in the cosmical ether, what clouds of meteoric matter, what strange forces we shall encounter in common with other members of the solar system, is yet to be learned. But *space* is no longer empty: day by day, as science advances, we have to acknowledge new-found denizens of its infinite expanse, and recognise new relations between the earth and the manifold occupants of celestial space which surround us.

Albeit, we know but little yet about those with the presence of which we have been so long familiar. We have yet to learn the functions of electricity in regard to climate; we have yet to measure how much of it is produced by the friction of millions of meteors rushing through our atmosphere, not to mention numberless other phenomena comparatively within our reach, but which, so far, are by no means within our knowledge. The

celebrated M. Arago, after a profound investigation of this subject, uses words that are well worthy of study, and with them I will close :—

"Thus the various phenomena of the celestial vault and of meteorology, even while they appear by their irregularity to defeat the sagacity of the human mind, are ultimately found by profound investigation to be connected by sublime relationship."

Discussion.

The Hon. John Smith, M.D., M.L.C., said this interesting contribution to the meteorological literature of New South Wales greatly extended the scope of Mr. Russell's former paper. He deserved great praise for the industry he had shown in hunting up the old records. He (Dr. Smith) had done something of this sort a few years ago for the Water Commission, hunting up notices of the weather in the newspapers, from 1802 downwards. He believed Mr. Russell had now exhausted all available sources, and they need not look for any additional information of value between the foundation of the Colony and the commencement of regular observations in 1840. All they had to do was to study carefully the facts collected. (In proof of the difficulty of getting trustworthy accounts of former years, Dr. Smith compared the statement of Captain Stokes, of the *Beagle*, as to the drought of 1838–9, with letters kept on record by a friend residing in Sydney. According to Captain Stokes there was no rain at all here for eight or nine months, including the period from November, 1838, to March, 1839; but the gentleman referred to mentioned several instances of rainfall in that period.) He (Dr. Smith) concurred in the theory of Mr. Russell, that we get our rain from the meeting of the cold polar wind with the warm moist equatorial wind (or the return trade wind). The zone of rainfall probably oscillates north and south, according as the polar wind or the equatorial predominates. A comparison of results at Hobart Town or Launceston, Wilson's Promontory, Twofold Bay, Sydney, Port Macquarie, Brisbane, and Rockhampton, would bring out the truth as to this oscillation. Last year Melbourne and Tasmania had more than the usual quantity of rain, while we had less. From this it appeared that either the return trade wind was too strong, or the polar wind was too weak for this Colony. If the fact of oscillation of the rain belt can be established, we should then go a step further and seek to ascertain the cause of the oscillation.

The Hon. L. F. De Salis, M.L.C., expressed his opinion of the high importance of Mr. Russell's paper. He (Mr. De Salis) firmly believed that there was periodicity in the weather of the Colony.

He had taken some trouble in examining the question. The rainfall was north or south according to the strength of the monsoon. This was ascertained by Mr. Todd, on the overland telegraph, where he had special opportunities for observation. We ought to avail ourselves of the trans-continental electric telegraph, to secure observations across the interior. He believed the sun to be the great motive power in all the weather. The moon also had an influence. He found by Admiral Fitzroy's work, that he was a powerful lunarist; and did it not stand to reason that these changes in cycles of nineteen years were connected with the moon running through all its course, as the eclipse proved, in nineteen years. Could anything be more likely than that the moon in going through all her grand changes would affect the weather? The moon affects the tide twice in every lunation; so it might affect the changes of the weather twice in every nineteen years. And he believed there were cycles of nine and a half years. Then the same weather occurred every thirty-eight years, that is twice nineteen years, or four times nine and a half years.

As to the nebulosity of the meteoric rings which darkened the sun, no doubt that also had some effect on the weather. There was a correspondence between the weather in England and here. He thought Dr. Smith's friend was not quite right about the drought of 1838–9. He had seen the diary kept by Mr. Close in those years, and it entirely corroborated the statement as to the extraordinary drought. The labours of Mr. Russell might lead to most valuable results, especially if they kept a record of the rain at different places in the interior. It would then be possible to prepare for a time of drought, and to mitigate its bad consequences. At present he believed three-fourths of the cattle in the interior had perished. And the drought was not over yet.

Mr. Russell, in answer to questions said, at every place on the earth's surface they would probably find a period peculiar to the place. There was some indication of a period of thirteen years here. The facts he had collected on the subject occupied 250 to 300 pages of manuscript. There was no proof that the sun's spots affected the weather.

The Chairman said, forty-two years ago he had collected in a book before him, materials bearing on this question, which confirmed Mr. Russell's view as to the causes of meteorological changes being cosmical. They were also connected with operations in the interior of the earth. He (Mr. Clarke), had traced changes of the weather as far back as 1101, and down to 1833.

A vote of thanks was passed to Mr. Russell.

Mr. Russell, in further illustration of the subject, said the rainfall differed much at short distances. Sometimes there was

No. 8.

CURVE SHOWING THE RAINFALL IN THE MIDLAND COUNTIES OF ENGLAND FROM 1730 TO 1860.

Each horizontal line is equal to 10 per cent. of the average rainfall, and each point in the curve is the mean of 10 years, thus 71 per cent. (1745) is from 1730 to 1740.

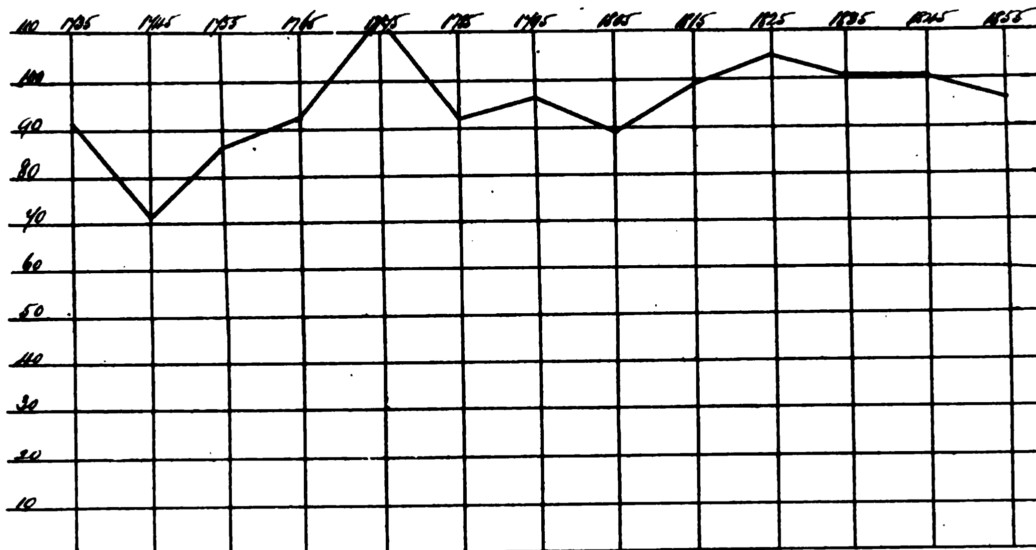

Photo-lithographed at the Gov't Printing Office, Sydney, New South Wales.

only 1-10th inch here while there was 1 inch at South Head. Tasmania has a very different climate from ours, quite insular, and there is no doubt a two years' period did exist for many years in Tasmania, but they never have really dry seasons there. The evidence of the nineteen years period here is I think so strong that it does not admit of much doubt.

[Three diagrams.]

EFFECTS OF FOREST VEGETATION ON CLIMATE.

BY THE REV. W. B. CLARKE, M.A., F.R.S., &c.

[*Read before the Royal Society of N.S.W.*, 1 *November*, 1876.]

AT our last meeting we had the pleasure of listening to a very able and instructive paper on "Meteorological Periodicity," by my learned colleague, the Colonial Astronomer, an essay which exhibited the results of his diligence and thoughtful discrimination.

The topic was one in which, in the course of my own researches, more than forty years ago, entered into a somewhat wider field than Mr. Russell has chosen for his special investigation, since it embraced not only Meteorological but other Physical phenomena, and especially the internal as well as the external influences that produce either recurring or abnormal changes in the organism of this planet and the health of its inhabitants.

I confess I felt a desire, on the occasion referred to, to say something relating to the last-mentioned of these effects, but the hour was late and the speakers had been many, and it was on the whole better to have deferred my comments on Mr. Russell's remarks till the whole of his design had been completed. At the same time I deem it fitting to acknowledge that my own inquiries justify a full reception of many of his conclusions, although his range of observation was limited rather to the illustration of our Australian region than extended to the more universal evidences derived from ancient as well as modern instances of "Meteoric phenomena, Vicissitudes in the seasons, and Prevalent disorders contemporaneous and in supposed connection with Volcanic emanations," which was the subject of various essays published by me in the years 1833–4–5.

I propose to-night to call attention to something in a different direction which has also a bearing on the interests of the Colony, which may have interest for some here present, and which only takes the place which I expected would have been occupied to-night by a discussion from another quarter on a somewhat allied branch of inquiry, in which Forest vegetation will be considered under a different aspect, viz., in relation to Geological influences.

These latter will only be incidentally alluded to in the following remarks.

It may, perhaps, have never been seriously contemplated by numerous persons who have traversed this territory, that the progress of clearing land in such a forest region as New South Wales must have various effects on Climate and Sanitary conditions, and that civilization has destructive as well as conservative tendencies.

I would not dwell on the influence upon scenery of improperly conducted clearings. A consideration of that kind can hardly enter into the mind of a person who can deliberately leave acres of unfelled timber, bare of foliage, barkless, and broken by the winds, such as might be enumerated by the score in some of the once most beautiful tracts in the counties of Cumberland and Camden; nor is it necessary to point out the array of giants of the forest that stud the summit of the Dividing Range at the back of Heidelberg, in Victoria, or examples of landscape scenery partly ruined by the ravages of insects. It may be true that the custom of *ring-barking* trees is productive, for a time, of some extra growth of grass; but to say nothing of the deprivation of shade to flocks and herds, or of waste of timber, as in the cedar districts of our eastern coast rivers by the ruthless and wilful wielders of the axe, who leave upon the ground to decay in ignominy some of the finest and most noble of our trees, I cannot help expressing great surprise that gentlemen who in general character and condition of life are far above the hungry and uneducated selector or wood-splitter can allow ring-barking in places where grass can never grow, and where nature embellished the rocks with woods. Such I have seen to be the case in many a spot far away from those before alluded to. It is a questionable policy that some of such clearings should have been permitted, and till the "woods and forests" have been taken under the protection of Government, many a district of rich timber will continue to be foolishly destroyed, and many a scene of sylvan beauty will be desecrated. A remark of this kind may perhaps be laughed at by some as not worthy of thought; but I can afford to put up with such a reception, in the consciousness that ridicule would be undeserved. The late Bishop of Australia once said to me, as we travelled together through a region of naked, ring-barked trunks of trees, that he wished some thousands a year could be put upon the Estimates in order to clear them from the land, and in that wish I doubt not many besides the Bishop have concurred. [*See Appendix, No.* 1.]

I pass on to something of, perchance, greater importance than one of mere artistic or æsthetic taste. Yet, before so doing, I would call to the remembrance of the Director of the Botanical Gardens the sentiments expressed by him and his companions,

when in the autumn of 1873, the Hon. Mr. Barlee, Colonial Secretary of Western Australia, and myself looked down from the edge of the escarpment over the relics of the beautiful jungle that once nearly covered the whole space in that part of the Illawarra which lies between Rixon's Pass and the ocean at Bulli, when we found that that most lovely patch of greenery, containing plants that are now being eradicated altogether, was in possession of a Company, who were about to undermine it in search for coal. I only regret that Mr. Moore's engagements have hitherto prevented his intention of describing the plants in that isolated patch and bringing its features before this Society. Hoping he may yet realise his intention, I will omit any further allusion to the scene.

The paper of Mr. Russell had distinct reference to droughts and floods; and in seeking to discover whether any and what periodicity exists respecting them in Australia, he made no allusion to any possible effect of our forest vegetation on climate. That there may be such effects, however feeble in comparison with the more formidable cosmical operations of nature producing atmospheric and meteoric phenomena, I firmly believe: and in order to justify my own conclusions I will refer to and quote the statements and deductions of other observers, who are entitled to the fullest reliance.

It is well known that many regions which were fertile in ancient times have since become desert, and that countries which were incapable of bearing fruit are now amongst the best wine-growing districts in the world.

Various causes have, no doubt, operated on the large scale in some regions beyond what we are now specially concerned with: and a passing remark may be made that, whereas in older geological epochs Coal measure vegetation, and in younger down to the Miocene era, as shown by Professor Heer, a rich flora extended over large portions of the Arctic regions, Greenland, which since A.D. 1348 has been blocked up by ice, then being covered by forest vegetation; so in times of Biblical history the waste treeless tracts of Syria, Egypt, and Palestine were well wooded, and fertilised by living streams—the present barren Wadys occupying oftentimes the channels of once strong running waters. Tacitus (*Germania*, v.) tells us that fruit trees would not thrive in the very country where now the vine is most luxuriant. He calls it *frugiferarum arborum impatiens*.

"If we ask," says Professor Schleiden, in his most delightful work "Die Planze, The Plant, a Biography," "the cause of this mighty change, we are directed to the disappearance of the forests. With the careless destruction of the growth of trees man interferes, to alter the natural conditions of a country. We can, indeed, now raise one of the finest wines upon the Rhine, where

two thousand years ago no cherry ripened; but on the other hand, these lands where the dense population of the Jews was nourished by a fruitful culture, are in the present day half deserts. The cultivation of clover, requiring a moist atmosphere, has passed from Greece to Italy, from thence to Southern Germany, and already is beginning to fly from the continually drier summers there, to be confined to the moister north. Rivers which formerly scattered their blessings with equal fulness throughout the whole year, now leave the dry and thirsty bed to split and gape in summer, while in spring they suddenly pour out the masses of snow accumulated in winter over the dwelling-places of affrighted men.

"If the continued clearing and destruction of forests is at first followed by greater warmth, more southern climate, and more luxuriant thriving of the more delicate plants, yet it draws close behind this desirable condition another which restrains the habitability of a region within as narrow as, and perhaps even narrower limits than, before. In Egypt, no Pythagoras need now forbid his scholars to live upon beans (*Nelumbium speciosum*); long has that land been incapable of producing them. The wine of Mendes and Mareotis, which inspired the guests of Cleopatra, which was celebrated even by Horace, grows no more. No assassin now finds the holy pine-grove of Poseidon in which to hide and lie in ambush for the singers hastening to the feast. The pine has long since retired before the invading desert climate to the heights of the Arcadian mountains. Where are the pastures now, where the fields around the holy citadel of Dardanus, at the foot of the richly-watered Ida, supported 3,000 mares? * Who can talk now of the 'Zanthus with its hurrying waves'? Who would understand now the 'Argos, feeder of horses'?"

After this burst of eloquence Schleiden quotes the thoughts of the venerable Elias Fries of Lund, and adds—"A broad band of waste land follows gradually the steps of civilization. If it expands, its centre and its cradle dies, and on the outer borders only do we find green shoots. But it is not impossible, only difficult for man, without renouncing the advantage of culture itself, one day to make reparation for the injury he has inflicted; he is the appointed lord of creation."

* * * * *

"Before him lay original Nature in her wild and sublime beauty. Behind him he leaves a desert, a deformed and ruined land; for childish desire of destruction, or thoughtless squandering of

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* "Three thousand mares his spacious pastures bred;
Three thousand foals beside their mother fed."
—Pope's Homer, xx., 262.

vegetable treasures has destroyed the character of Nature, and terrified man himself flies from the arena of his actions, leaving the impoverished earth to barbarous races or animals, so long as yet another spot in virgin beauty smiles before him.

"Here again in selfish pursuit of profit, and consciously or unconsciously following the abominable principle of the great moral vileness which one man has expressed *après nous le déluge*, he begins anew the work of destruction." (Henfrey's Schleiden's Eleventh Lecture, p. 304–6.)

There is much in this reasoning of the German professor which agrees with the sentiments of the late Sir Henry Holland, Bart., who in an able critical essay in the *Edinburgh Review* of 1864, of Marsh's excellent work "Man and Nature," says:—"It is the forest which actively ministers to the climatic conditions of the earth, which, extirpated by the axe or restored by planting, changes both the face of nature and the distribution and destinies of human life." The simple name of Forest will hardly bring to the casual reader a conception of all that it implies; of the vast extent of the earth's "surface thus covered in every zone to the very confines of the Arctic Circle; of the various aspects and qualities of this great forest mantle, and of its relation to all the moving elements of the natural world. It is impossible to estimate, even by loose approximation, the actual extent of surface so occupied. We have given reasons for believing that the earth was largely covered with wood at the time when man first became its denizen." Mr. Marsh himself enters most minutely into the use and value of Forest vegetation, and describes with accurate care the effects consequent on the clearing of his native American lands by the axe or the prairie fire:—"With the disappearance of the forest all (he says) is changed. At one season the earth parts with its warmth by radiation to an open sky, and receives at another heat from the unobstructed rays of the sun. Hence the climate becomes excessive, and the soil is alternately parched by the fervour of summer and seared by the rigours of winter. Bleak winds sweep unresisted over its surface, drift away the snow that sheltered it from the frost, and dry up its scanty moisture. . . . The washing of the soil from the mountains leaves bare ridges of sterile rock, and the rich organic mould which covered them, now swept down into the damp low grounds, promotes a luxuriance of aquatic vegetables that breed fever and more insidious forms of mortal disease by its decay."—("Man and Nature, or Physical Geography as modified by Human Action." By George P. Marsh. 1864.)

The reviewer of this enthusiastic work points out where the author leans too partially to one side of his argument, but fairly joins him in affirming that "vegetation, under the form of woods, is

necessary, more or less, to the well-being of every country; and that many regions once fertile have become otherwise by the loss or curtailment of this magnificent provision of Nature for their covering." He points out that there is a remedy in "planting fresh forests where none exist—(*serit arbores quæ alteri sæculo prosint*)," and refers to Mr. Fox Wilson's memoir, read before the British Association, "regarding an extensive region in the Orange River territory of South Africa, bearing marks of having been formerly well wooded, but now utterly treeless and barren."

This will be noticed hereafter.

It has been stated by Dr. Kelly (Transactions of the Literary and Historical Society of Quebec, III., part 1, p. 46), from comparison of ancient documents, that the climate of Canada has not varied much for the last 200 years; and by other writers, that England in the time of the Norman Conquest, about 800 years ago, resembled that of Canada in its extremes of heat and cold, its dense covering of forests, and its growth of vineyards and accumulations of winter snows and ice. Grapes certainly ripen now in the south-eastern part of England when properly cared for, as I know they did on the walls and roof of my father's house; and, I believe, even as far north as Archangel, in Russia; but it is impossible to doubt that the clearing of the forests which formerly covered three-fourths of the country has modified the climate of England, whilst a change in an opposite direction has been said by Mr. Williams to have taken place by the introduction of the hawthorn hedges (*Cratægus oxycantha*) that now universally obtain. That author says, in his book on the Climate of Great Britain, that during sixty or seventy years previous to his publication, these hedges had produced wet summers.

Perhaps this method of dealing with the subject may be considered too vague to carry conviction with it; but it is only within a few years past that Climatology has taken the appearance of an exact science, and observations respecting any of the elements of Meteorology—still in its infancy, and only yet partially understood—had no existence in the distant periods to which, for comparison with the present, we are called upon partly to have recourse. Moreover, all climates are merely local; and what may be strictly true of one region may have little relation to the particular conditions of another. Nevertheless, there are certain general facts that may be so applied, and specially in such an inquiry as the present, though many of the circumstances may be wanting to meet the strict objects of what is called modern Science. Each country has its own peculiar characteristics, and there are many geological data to be considered in relation to climate before what applies to one region especially

can safely be made strictly applicable to another widely separated from the former. Still, there are certain conditions always capable of entering into the practical working of the problem, such as the effect of forest shade as preventing evaporation—the electrical agency of foliage, so great as to cause a single tree to produce sufficient electricity to charge a Leyden jar—the condensation of atmospherical vapour, and other agencies, which all belong to the question before us.

There is also a reciprocal effect of Climate on vegetation, which cannot be omitted, if perfect balancing of elements enter into the problem to be solved.

And yet we shall find that the Author of the Universe has provided peculiar and wondrous machinery to meet exceptional cases. Take, for instance, the influence of Vegetation on the atmosphere in the case of what a botanist of eminence, and an author of some interesting works on botanical subjects about half a century ago, included in his account of "Raining Trees." He enumerates the willow and poplar as producing even a gentle shower when grouped together. The properties of such plants as *Cornus* (*macula*), the *Tillandsia*, *Nepenthes distillatoria*, and other pitcher plants, which are resorted to by monkeys and mice, and especially the "Rose of Jericho" (*Anastatica hierochuntina*), that extraordinary succulent which inhabits the surface of a burning desert, were experimented upon by the author I refer to, Mr. Murray, F.L.S., who reported on the latter to the Horticultural Society of London.

Mr. Murray refers to a tree met with by Cockburn ("Voyages") at Vera Paz, in South America, which distilled water from the end of every leaf, and in a time of extreme heat had wet ground around it, and names a *Calla* and an *Agapanthus* as affording a counterpart. He further cites Glass's "History of the Canary Islands," as to a tree in the Island of Hierro, called *Til* by the natives, to which they applied the term *garse* or sacred, and which had the property of condensing vapour, so that rain, as it were, fell from it so copiously that it was received in a tank and meted out to the inhabitants.

To justify in some degree this to some apparently incredible fact, Mr. Murray mentions what is capable of more easy verification, viz., that in avenues of elms and Lombardy poplars, when a fog prevails, though the ground outside the leafy border be dry and parched, within the limits of the foliage it is wet, and he states the time when he noticed this to have been in the month of September, 1828, and that the place where this kind of rain fell plentifully from the trees was on the road between Stafford and Lichfield.

He adds a passage which I will quote entire:—"The great rivers of Europe have their supply in the Glaciers; but many of

the rivers in the New World owe their origin to the forests of America, and their destruction might dry up many a rivulet, and thus again convert the luxuriant valley into an arid and sterile waste; carried further, the principle extends to the great features of the globe. What the glaciers effect among the higher regions of the Alps, the *Pinus cembra*, and *Larix communis* accomplish at lower elevations, and many a mountain rivulet owes its existence to their influence. It rains often in the woodlands when it rains nowhere else, and it is thus that trees and woods modify the hygrometric character of a country; and I doubt not but, by a judicious disposal of trees of particular kinds, many lands now parched up with drought, as for example, in some of the Leeward Islands, might be reclaimed from that sterility to which they are unhappily doomed." (M. N. H., vol. IV., p. 32–34.)

I shall, before I conclude, put in evidence what will prove the truth of this suggestion from one of the group of islands mentioned.

But before I proceed, I wish to mention a statement made to me by more than one reliable informant respecting the power of Australian trees in time of drought to produce water from their roots. I was travelling with a friend in the month of January of the present year in the valley of Bylong in the county of Phillip, during the height of the drought. Among other circumstances brought to our notice was this—that water had made its appearance by springing up in several places where none had ever before been noticed, and the explanation given was that such water came from the roots of the gum trees. This opinion I heard uttered by several close observers, and I think it possible, when one considers the nature of the roots of these trees, and the effect of drought in contracting the wood, in checking the ascending sap and squeezing it out. I name this more to elicit observation and explanation from others than to lay it down as a fact sufficiently established; but I am inclined to believe there may be more in it than is "dreamed of in our philosophy" of droughts; and I know no other solution for the fact, if it be such, than the one I have suggested.

Professor Dobereiner, of Jena, mentions in the *Bibliothèque Universelle* that it has been noticed that on the high mountains of South America the trees continually transpired a quantity of water, even in the driest weather, the water falling sometimes as rain. This is a parallel case to that cited before from the island of Hierro.

Certain trees have been tapped for a supply of water, and the roots have often been found to discharge it sufficiently to assuage human thirst. These have been called the "Traveller's Tree."

Now, I believe it has been ascertained that the fibres of wood in trees are composed chiefly of carbon, oxygen, and hydrogen—

the two last in the proportion to form water; that the specific gravity of the sap is least at the roots, and that (which may be the cause of the hollowness of some of our Australian trees) it ascends in the greatest quantity in the newest layers, and that the innermost layers become clogged and hardened in the process of assimilation, so that the vitality ceases there, and the sap becomes deprived of the aqueous part of its constituents by the deposition of ligneous matter.

How water may be collected from *invisible* sources is a difficulty for chemists and naturalists, which I do not venture to solve. But, when we read of white ants, during a severe drought in the heated parts of Africa, finding plenty of moisture beneath the surface for making their plaster, though three inches deep the thermometer stood at from 132° to 134° Fahrenheit—and of other insects distilling (under experiment) from the castor oil plant 16 ozs. of water in twenty-four hours, which are the statements of Dr. Livingstone in his Missionary Travels (pp. 21 and 416, ed. of 1857), we must think that we know very little at present of either vegetable or animal life.

"We must," to use the great traveller's words, "leave it for naturalists to explain how these little creatures distil both by day and night as much water as they please, and are more independent than Her Majesty's steamships with the apparatus for condensing steam—for, without coal *their* abundant supplies are without avail."

It may be truly said that such phenomena as these can hardly belong to the "effects of vegetation on climate"; but in relation to drought, which is very intimately connected with climate, it may do no harm to show that there are alleviations of such a calamity for some of God's creatures, which defy the wisdom of man to parallel. We may thus be led to study the mysteries of the visible creation with humility as to what we cannot discern, and with hopefulness as to what, by well-tempered zeal and proper direction of what we may be permitted to discover, our Sciences will finally attain.

If, by a just employment of observation, we can arrive at any positive means of counteracting the adverse, or employing the friendly forces of Nature to our advantage, it is not only permitted us so to do, but it is our duty to do it, for the good of mankind; and it is not beneath the aim of rational and accountable beings to seek guidance as to the planting of a wilderness or the clearing of a jungle, if either be necessary, by inquiry as to the facts which may be obtainable by experience, and accepted as warnings or encouragements.

There are some facts in relation to the ability of certain trees to discharge water from their roots which will justify further reference to this branch of the subject, especially as the examples will be selected from Australia, and have a bearing on its sanitary conditions.

In a very important and valuable communication by Mr. Joseph Bosisto, M.P., one of the Commissioners of the Philadelphia Exhibition, to the Royal Society of Victoria, we find the characteristics and sanitary value of the *Eucalypti* shown by chemical analysis of their volatile products.

The author says—"The Mallee country plays a very important part in the climatic influences of Australia. * * * * * The nightly and morning dews of the mallee country are frequent in spring and summer. This is in part owing to the suspension of water in the air during the hot days from the river Murray and its tributaries, as they pass for a considerable distance through this scrub, but the greater amount of the dew moisture is owing to the exhalation of the leaves, for it must be remembered that, although the surface soil is dry and hard, the roots go down to the moist undersoil obtained from the salt-water springs. During the severe droughts to which this country is subject the trunks of these dwarf trees are *full* of moisture, but so poor of sap constituents that in one of the species in particular, when the trunk is cut down close to the roots, and placed in a bushman's panikin, a cool and refreshing draught of water is obtained, to the great relief of a weary wanderer in this lone and dreary scrub."

Mr. Bosisto goes on to say that it is held, on the lowest calculation, that in New South Wales and South Australia the mallee country is twenty times the area of similar country in Victoria, and that "96,877,444,000 gallons of oil are held at one and the same time in a belt of country over which the hot winds pass; and considering also that the same condition exists throughout the major part of Australia with the other *Eucalypti* as that which exists in Victoria, we cannot arrive at any other conclusion than that the whole atmosphere of Australia is more or less affected by the perpetual exhalation of these volatile bodies." He quotes the address delivered by Dr. Andrews, in December, 1844, before the Royal Society of Edinburgh, in which he states that "volatile oils, like phosphorus (*i.e.* in common with) have the power of changing oxygen into ozone while they are slowly oxidizing." He cites also Dr. Day, of Geelong, whose researches on this subject are well-known, and who has "demonstrated that the *eucalyptus* oils absorb atmospheric oxygen, transforming it into peroxide of hydrogen." He concludes from the facts demonstrated in his essay that "whatever change may take place in the condition of the atmosphere, arising from the free and large supply of these chemical bodies in the air, it is, from all known evidence, of an invigorating and healthy nature and character." "Death (he says) lives where power lives unused, and were it not that such happy and benign influences as those exerted by the *eucalyptus* vegetation existed around us, *independent of ourselves*, we might mourn our

fate. In conclusion, may we not say with some authority that the evidence set forth in this paper on our own vegetation is in favour of the *eucalyptus* being a fever-destroying tree?"—(*Essays, Victorian Catalogue, Philadelphia Centennial Exibition*, 1876, *p.* 87–91.)

The Baron von Mueller also notices the properties of the Mallee scrub with respect to water ("Fragments," ii. 57), where he says, "Radix horizontaliter longè procurrens largam aquæ puræ copiam retineat." In another of his valuable publications the Baron refers to Mr. Bosisto's experiments, and mentions also his own recommendations to that gentleman in 1854 to distil the *eucalyptus* oil, pointing out how greatly the growth of the trees which our settlers cut down indiscriminately is now encouraged and adopted in Europe, America, Africa, and New Zealand. He points out the sanitary benefits arising from our gum forests, shows how invigorating, as well as cheerful, is their presence, in comparison with the treeless plains, and ends a most delightful essay with these weighty expressions: "I regard the forest as an heritage given to us by Nature, not for spoil or to devastate, but to be wisely used, reverently honored, and carefully maintained. I regard the forests as a gift intrusted to any of us only for transient care during a short space of time, to be surrendered to posterity again as an unimpaired property, with increased riches and augmented blessings, to pass as a sacred patrimony from generation to generation. ("Forest Culture in its relation to Industrial Pursuits": a Lecture delivered by Baron Ferdinand von Mueller, C.M.G., M.D., Ph. D., F.R.S., on 22nd June, 1871.") [*See also Appendix No.* 2.]

In addition to the preceding remarks on the Mallee scrub, it may be proper to mention that there is a very useful paper by Mr. Cairns, in the Transactions of the Philosophical Institute of Victoria (vol. III., 1858) on the *Weir Mallee* (*a water-yielding tree*) of Australia. This tree fully bears out all that has been said above. It has been long known to the Aborigines, to the early settlers, and to botanists, as capable of supplying, when the roots have been cut to lengths of from 20 to 30 feet, and placed upright in a vessel, a pint or quart of pure water, a wonderful provision for thirsty wanderers in the bush. Mr. Eyre tells us that during his fearful journey along the coast of the Australian Bight in 1841, his two aboriginal lads procured him a third of a pint of water in this manner in a quarter of an hour, and says that "natives who, from infancy, have been accustomed to travel through arid regions, can remain any length of time out in a country where there are no indications of water." (*Central Expeditions into Australia*, by Edward John Eyre, vol. I., p. 350.]

We are not however to conclude that all *Eucalypti* will be as profitable as those mentioned; but the facts are, I doubt not, as stated.

Hakea stricta also supplies a small quantity of water in the same way. [*See Appendix No.* 3.]

I confess, however, I cannot understand statements made to me by more than one observer, that ring-barking trees is a greater source of water than allowing them to live. One friend has informed me that "within the last fifteen years about two-fifths of the timber in the watershed of the Hunter has been destroyed by sapping or ring-barking, and that the number of cattle and sheep is three times as great as it was fifteen years ago, and that the chief result which has followed sapping, *in every place and without exception*, so far as his observations have gone, has been that the creeks which were formerly dry watercourses, only containing water for a few days after heavy rain, have become permanent streams and, even in last year's very dry weather, showed no signs of failing. This result was quite unlooked for by those who sapped the land. There are, he says, on his own run two creeks flowing from opposite sides of the same range. One which flows west used to have water except in very dry seasons, and was taken up by selectors twelve years since. The other flowing east had no water, and so was not taken by selectors but was purchased by me, and all the timber in its watershed sapped. There is a strong stream of water running in it now, and has been for the last five years; whilst last summer the selectors on the other creek were very short of water, and are now sapping the timber so as to cause a flow of it."

It seems to me perfectly clear that there may be other physical causes than the one suggested by my friend for the local alteration in the water supply. Admitting with him, as I do, that the forests at the head of the drainage, on the main ranges, have not been touched, and that the average rainfall has not been diminished; perhaps, in the increase of cattle and sheep spoken of, trampling down the soil may have occasioned more water than of old to run off to the creeks instead of sinking into the soil. The solution suggested appears to me very much akin to the old logic respecting Tenterden steeple and the Goodwin Sands, the former of which was facetiously held to be the cause of the latter.

The mass of evidence supplied in the present paper from all parts of the world must, I humbly conceive, overbear any inference from unexamined actual phenomena brought against that evidence; but it would be unwise to test the supposition by clearing away every stick of wood from the ground with Vandalic extermination, which would be the only wise course if cutting down trees or killing them off whilst standing can really change dry gullies into living streams.

It is not to be doubted that judicious clearing is a benefit, and it may be admitted that grass does not always prosper in imme-

diate reach of droppings from certain trees, but this, which is due to chemical action, is but a small drawback from the actual sanitary blessings we have bestowed on us by the abundant growth of forests in which these trees are the principal members. A careful perusal of Mr. Bosisto's paper before mentioned, and the learned treatise on "Air and Rain—The beginnings of a Chemical Climatology, by Robert Angus Smith, Ph. D., F.R.S., F.C.S., 1872," will, perhaps, be sufficient to show that there is much which to the masses of readers and writers is a kind of *terra incognita*, which has as yet to be explored before we can dogmatize on some of the hidden operations of Nature in regard to vegetation.

I will therefore now bring forward many good examples from foreign countries as to the effect of "forest vegetation on climate"; and here I would remark that by "Climate" we are not to understand exactly what popular use makes of the word. "The single word 'climate,'" says a writer whom I have before quoted, "expresses one of the most important relations of man to the natural world around him—a relation which concerns human existence in its every part. But this word climate, taken in its largest sense, comprehends within itself all those elements of matter and force, the mutual influences and actions of which produce the phenomena so familiar to us under the single expression."

Dr. Daubeny (Lectures on its influence on vegetation) defines "the climate of a country to be its relations to temperature, light, moisture, winds, atmospheric pressure, electricity, and so forth; but assigns to its first place heat and its distribution. The present object is to illustrate how one of these relations, viz., moisture, is affected by forest vegetation, the reverse of the action understood by the Professor.

If the cutting down of a forest alter the atmospherical conditions of any spot, it may be said to affect the climate of that spot, and *vice versâ.*

If it have any effect on the supply of water to a river, then it affects its climate in another way; and in either case men's health or the advantages of life or animal existence in such spot may be affected.

There is therefore propriety in using the expression "climate" to indicate such a condition of things as existed before changes that may take place.

The late Professor Daubeny, whose work on Climate has just been cited, gives some useful illustrations of the effects I am engaged with. He quotes Boussingault's example of the Lake of Valentia in Venezuela, which has no outlet, but receives water from rivers and creeks, and where, in regard to the fall of rain and the humidity of the district a change was produced affecting the province.

Humboldt's account of the lake was that its waters were lessening, so that beautiful plantations of bananas and sugar-canes had taken the place of water—in some way like the change that has occasionally altered the condition of Lake George in this Colony.

This falling off was occasioned by the felling of timber, occasioning a deficiency of water in the rivers. Twenty-five years afterwards, Boussingault visited the lake and found its dimensions increasing, owing to the War of Independence having occasioned a cessation of clearings, so that less timber was being cut down, and rain fell in greater abundance than before.

That this is the true explanation was shown by other lakes in the neighbourhood, which had undergone no change of level, the timber on the surrounding mountains having remained in the state of nature.

The lakes of Neufchatel, Bienne, Morat, and Geneva have been mentioned as examples of similar diminution by Humboldt and Saussure; and Gasparin has shown that during the last century the annual amount of rain was stationary at Paris, Milan, and other places, leaving the inference that the clearing of forest country had produced greater evaporation.

The island of Ascension is next quoted as confirmatory; for the only spring existing in the island was dried up by the removal of the trees, and on the restoration of the timber the lost water returned.

This conclusion was, however, disputed by Boussingault, who contended that the trees impeded evaporation, because the island is too small to affect the rainfall. But Daubeny says, "It is enough for our purpose to substantiate the fact that by the removal of forests we have it in our power to modify the character of the country with respect to humidity, whether this be brought about in one way or the other; of which fact I apprehend there is abundance of proof."

To the instance of Ascension Island I would add that of St. Helena, which in 1506 was discovered to be entirely covered with forests, but when Dr. Hooker visited it a few years since he found five-sixths of the island barren, and the remainder occupied almost entirely by trees, shrubs, and other plants introduced from Europe, Africa, America, and Australia. The destruction in this case was by goats, and by the inroad of the new vegetation, supplanting the young shoots of native trees. In the days of its first occupation abundance of springs were found to rise from the hilly igneous rocks of the interior. But the country had become dry, and in some places waterless. In 1848, according to

the Island Almanac of that year, the rain had increased, which was attributed to the increase of wood. Floods had also decreased during the last eight years. It is said that during the present century the rainfall has nearly doubled. (Bombay Geogr. Society's Report, 1849–50, p. 55.)

A gradual decay of Great Britain was predicted in the *Times* newspaper in 1862 from exhaustion of vegetable mould, and Liebig exploded the idea that such mould, with tillage and manure, will suffice to prevent exhaustion; but Daubeny remarks, that many countries that once were fertile enough to maintain a large population are now barren and desolate admits no dispute, and he adds:—"To me the cause of this deterioration appears obvious as arising from the denuded state of those countries as regards timber, for which we need not go further than to many of the islands of the Archipelago, to parts of Greece, and even of Italy."

On the other hand, he maintains that where a country enjoys sufficient humidity, and the natural soil supplies suitable and sufficient mineral constituents, as proved by the Nile and by Naples, Tuscany, and even parts of Sicily, there will be no general exhaustion. And where the reverse is the case, he attributes it rather to the aridity occasioned by the destruction of forests than to the exhaustion of the vegetable matter itself.

Lastly, he cites Lower Egypt, where it has been usual to say no rain ever falls and the Nile does all the work; but since the late Pasha took to the planting of trees heavy showers have fallen about Cairo and Alexandria and in other parts of Lower Egypt.

As plague, locusts, and other vexations used to trouble the Egyptians when the Nile did not rise, it is surely as satisfactory to our medical as to our meteorological Section to know that an amelioration of the climate of Egypt has been partially effected through the instrumentality of trees; and who can tell what would be the further effect upon sanitary methods if some of our *Eucalypti* were brought as much into request in Egypt as, I understand, they have been in certain parts of Italy and elsewhere?

In addition to previous references to America, I may mention here that in Kentucky many brooks have become dry in summer which, for thirty years before the clearing of timber, were never known to fail; and in New Jersey, where the clearings were more extensive, some streams entirely dried up. On the other hand there are examples of the contrary—but the explanation given by the writer, to whom I am indebted for this statement is, that the tillage of the soil allowed the water to penetrate deeper, and cleared away the mass of leaves that caused the water to be more exposed to evaporation, though there has been no alteration in the rainfall.—[J. R. Mag. Nat. Hist., 1834.]

Looking to South America we find that similar conditions may be traced to those in the northern part of the continent. For instance, the inhabitants of the country assured Humboldt that the extreme aridity of the plains in about latitude 9°, between the Orinoco and the Andes, was occasioned by a diminished fall of rain, and that since the arrival of the Spaniards the trees had been destroyed. He says it is well known that in Caraccas the climate was destroyed by the removal of the trees, and that rain formerly abounded where now there is none, and after some reasoning, adds—"It results that the destruction of forests, the want of permanent springs, and the existence of torrents, are three phenomena closely connected together." Dr. Duncan shows the same results for the Deccan. The Cape de Verds show the same connection. Many others instances are named by Dr. Balfour, and, as we read in the Report of the Bombay Geographical Society for 1849, "thousands of similar instances might be quoted." It would be unfair to omit to mention one of the most remarkable of them. I allude to that of the Mauritius, quoted by Von Mueller. Dr. Rogers very recently issued a report "On the effects of the cutting down of forests on the climate and health of Mauritius." In 1854 the island was resorted to by invalids from India, as the "pearl" of the Indian Ocean, it being then one mass of verdure. When the forests were cleared to gain space for sugar cultivation, the rainfall diminished even there; the rivers dwindled down to muddy streams; the water became stagnant in cracks, crevices, and natural hollows, while the equable temperature of the island entirely changed; even drought was experienced in the midst of the ocean, and thunderstorms were rarely any longer witnessed; the lagoons, marshes and swamps along the sea-board were no longer filled with water, but gave off noxious gases; while the river waters became impure from various refuse. After a violent inundation, in February, 1865, followed by a period of complete dryness, fever of a low type set in, against which the remedies employed in ordinary febrile cases proved utterly valueless, pestilential malaria arose, exposed to which the labourers fell on the field, and, in some instances, died within a few hours afterwards." * * * * * Dr. Rogers very properly insists that the plateaux and highlands of Mauritius must be replanted."—(Von Mueller, Lecture, 22nd June, 1871, reprinted at San Francisco.)

Those who think the evidence afforded on the subject is not sufficiently scientific will hardly use that argument against Arago, who declares that "forests cannot fail to exercise a sensible influence on the temperature of the surrounding regions. The destruction of forests ought therefore to produce modification of our climates." He says also: "Clearing the wood from

a mountain is the destruction of a number of lightning conductors equal to the number of trees felled; it is the modification of the electrical state of an entire country; the accumulation of one of these elements indispensable to the formation of hail, in a locality where previously this element was dissipated by the silent and incessant action of the trees. On this point (he says) observations support theoretical deductions. According to a detailed statistical account, the losses occasioned by hail in the continental states of the King of Sardinia, from 1820 to 1828 inclusively, amount to the sum of *forty-six millions* of francs (£1,916,666 sterling). Three provinces, those of Val d'Aoste, the Vallée de Suze, and Haute Maurienne, do not appear in these tables; they were not visited by hail storms. *The mountains of these three provinces are the best wooded.* The warmest province, that of Genoa, the mountains of which are well covered, is scarcely ever visited by this meteor." * * * * "It is said to have been remarked in Italy, that in proportion as rice-fields multiply, the annual quantity of rain has gradually increased, and that the number of rainy days has augmented in proportion." Again,—"the wind exercises a *direct action* on vegetables, often very injurious, and which ought to be carefully distinguished from climatological action. It is against this direct action that curtains of wood, by forming a shelter, are especially useful. The direct influence of the wind on the phenomena of vegetation is nowhere more strikingly exemplified than in the Isle of France. The south-east wind, very healthy both for man and animals, is on the contrary, a perfect scourge to the trees. Fruit is never found on the branches directly exposed to this wind; none is to be found but on the opposite side. Other trees are modified even in their foliage; they have only half a head, the other has disappeared under the action of the wind. Orange and citron trees become superb in the woods; in the plain and where they are without shelter they always continue weak and crooked."—*Annuaire pour l'an* 1846.

Professor Laurent, of Nancy, instances Fontenay and Provence as places where the felling of forests has affected the climate. Wells and pits have become dry on this account. In the whole of the Eastern Pyrenees and the Herault, the felling of timber has been attended by serious consequences. The temperature becomes higher, wells and watercourses diminished, and the dryness of the climate was much increased. He also quotes similar results in the Vosges, Department of Garde, Nismes, Bezieres, Isere, &c.—*De l'influence de la Culture sur l'Atmosphère, &c.*

Professor Chaix, of Geneva, attributes the well-known floods and inundations of the Rhone, such as those of 1803, 1810, 1811, 1840, 1841, 1842, in part to the destruction of the great extent

of forest in the high lands of the basin of the river. He says the work of the axe was very extensive during the first twenty-five years of the present century.—*Extracts from a letter. J.R.G.S.*, XIV, 328.

A very striking instance of the mischief of clearing a forest injudiciously was given to me by a correspondent in the West Indies, the late Rev. Landsdown Guilding, of St. Vincent, some of whose remarks I quoted in the year 1835, in a paper of similar kind to the present. Writing in May, 1830, he says:—"The inhabitants of Europe may well be astonished at the quantity of rain which falls in hot countries. I shall subjoin an account of the quantity measured in this island from 1823 to 1829 inclusive." [*See Appendix No.* 4.] "This it must be remembered fell on the sea coast. If measured on the mountains it would exceed belief. I have several times slept on the high volcano of Morne Soufriére during a night of storm and thunder, when the water descended in a sheet, filling rapidly every empty wine bottle, and ploughing up the volcanic gravel into innumerable gutters, widening as they went into ravines of frightful depth. The climate has been considerably affected by the continued industry of man and his daily encroachment on the primeval forest. In the valley of Mariaqua, two fine cataracts which used to adorn the landscape and rush down the sides of Grand Bon Homme, are now not visible after heavy rain; and many portions of the cultivated lands in dry seasons suffer to a lamentable extent. So much has this change been felt, that laws have been passed to prevent the cutting down of timber in certain directions under heavy penalties. The planters in the suffering districts have long since seen with alarm the fatal mistakes of their predecessors in denuding the mountain ridges of their neighbourhood; and have, for many years, planted these parts again. But, in their short-sighted folly, trees were selected which attained but a very moderate height, merely because the wood was useful for cart work. To have remedied the serious evil under which they and their descendants were to suffer they should have entered the forest and selected the seeds and saplings of these giant figs and other fast growing native trees, which, though useless as timber, would soon by their height and magnitude have attracted, detained, and broken the rolling clouds, which now pass over to the interminable and pathless woods."

This valuable letter contains not only additional evidence of the influence of forest vegetation on climate, but gives an excellent hint as to the proper course to be pursued to remedy the effects of injudicious destruction of trees in a country subject to high temperature. In the 5th edition of Lyell's "Principles of Geology" (very much changed in the 10th edition) we have many interesting particulars relating to the subject in hand which will repay the trouble of reading.

The following extract from the *Times*, of 16th August, 1876, may tend to show that St. Vincent is not alone as suffering from destruction of woods in the West Indies :—

In reporting on the agriculture and industry of the Danish West Indian Island of St. Croix, Consul Palgrave has to state that of late the year's rainfall has barely averaged 34 inches, and in 1875 it was below 27 inches in the Christiansted division, and was quite inadequate to secure a moderate sugar crop for 1876. Mr. Palgrave says that the rainfall was certainly much more copious in former times. Traces of a tree-growth impossible with such a scanty moisture supply, of shrunken or dried-up pools, and of stream channels where nothing now flows, exist everywhere throughout the island. This unfortunate climatic modification has, it seems, become normal, not in St. Croix alone but throughout the Virgin Islands and the northerly region of the Lesser Antilles for the last fifteen years or thereabouts.

There are other instances which I would wish to bring forward on this occasion, the former of which, in September, 1835, I first noticed in the "Magazine of Natural History." I refer to the forest of Bialowieza in Lithuania, of which a description was edited by the Baron de Brincken, Chief Conservator of the National Forests of Poland, and member of the Department of Forests. This work was published at Warsaw in 1826.* It was afterwards, in 1845, briefly noticed by Murchison, De Verneuil, and Keyserling, in their great work on the "Geology of Russia and the Ural Mountains," in connection with an account of the forest, as the abode of the Bos Aurochs or Zubr, supposed to be the Bos Urus, or Bos priscus of antiquity, and a specimen of which was obtained and presented by Sir R. I. Murchison to the Royal College of Surgeons, for the investigation of Professor Owen, a description of which is to be found in the Zoological Society's proceedings for 1848, p. 12 to 13.

Sir Roderick's notice of De Brincken was in connection with an "Account of the Forest of Bialowieza, the habitat of the wild Aurochs or Zubr. By Count de Kraskinski (in a letter to Colonel Jackson, Secretary of the Royal Geographical Society of London)."

This forest was formerly a favourite hunting ground of the royal family of Russia, and remained free from clearings much after the fashion of an American forest. It contained, to a late period, numerous wild animals of the chase, of which the Auroch, or Bison, or Zubr was the chief.

We need not go further into the history of its inhabitants, but may refer at once to the Baron de Brincken's statement. Indeed, I have only time to make a few slight quotations from my own

*Mémoire descriptif sur la Fôret Impériale de Bialowieza en Lithuanie ; redigé par le Baron de Brincken, Conservateur en Chef des Fôrets Nationales de Pologne ; membre du Département des Fôrets à la Commission des Finances et du Trésor, Chevalier de l'Ordre de St. Stanislas, 2me classe ; Orné de quatre gravures et d'une carte. Varsovie. Chez Glucksberg, 1826, 4to, pp. 127.

abstract of his work. This forest lies not far from Orla, and is bounded by the old frontier of Poland and Lithuania, where it is about 25 miles in circumference, being seven geographical miles in length and six in breadth, lying in latitude from 52° 29′ to 52° 51′ N.

It is flat and sandy with lakes; the *Abies picea* occupies with the *Pinus sylvestris* four-fifths of the soil, of which the proportion of *humus* to the sand is as 1 to 4. The other trees are Taxus baccata, Quercus robur, Carpinus betulus, Betula alba, Alnus glutinosa, A. incana, Salices, Tilia parvifolia, T. grandifolia, Populus nigra, alba and tremula: Pyrus malus sylvestris: P. pyraster, Cerasus padus, Acer campestre, A. pseudo-platanus, Ulmus campestris, Fraxinus excelsior. There are also some shrubs which are enumerated in Gilbert's *Flora Lithuanica* (1781).

Here, then, we have a country of forests without mountains, and its climate peculiarly cold and severe. All the region north of the Carpathians, as far as the Baltic, is exposed to the cold and dry north winds from the swampy forest plains of the deserts of Russia and Tartary, whilst to the south of the mountains grow the grapes of Hungary and the fruits of the south. The mean temperature of Lithuania is about 44° F. Its weather is stormy, now cold, then intensely hot; warm by day in summer, cold at night. Near the forest of Bialowieza the cold is greater, and the harvests later by eight or ten days than at some distance from it. So much so, that sledges are used on the snow, whilst the peasants a few miles away are preparing to till their land.

Now, here we come into relation with the river-producing power, like that of mountainous regions. It is the *forest* which causes the waters of the heads of the Narew and Bug that belong to the great basin of the Vistula. The Narewka and Biala bear vessels even in the *forest*. And thus we find that high mountains and glaciers are not essential to the formation of rivers.

Humidity and vegetation act reciprocally on each other, and the leafy trees which have the greatest share in the action upon the atmosphere grow in the marshy and damp spots of the Forest of Bialowieza.

The value of this example will be seen if we refer to such principles as have been maintained respecting climate by such writers as Lyell and Daubeny. Malte-Brun also argues that the west winds in Poland, which blow for three-fourths of the year, are humid, the north are also moist though cold as are the south, and the east the coldest of all. Globes of fire, parhelia, falling stars, the Aurora borealis, and violent storms characterise Poland.

Sir Roderick Murchison (Russia and the Ural, p. 578) has these remarks:—"The hands of man have also produced and are still effecting considerable changes in large tracts of Russia, by the destruction of her forests and the conversion of her northern marshes into arable lands. A few centuries only have elapsed since northern Russia was a dense virgin forest, with vast intervening marshes and lakes, but now her gigantic pine trees are felled, lakes and marshes are drained, and the culture of corn is extended to the latitude of the White Sea. The natural recipients of so much moisture having been destroyed, we may (exclusive of the great spring *débâcle*, which in an extreme climate may have been always nearly the same) in great measure account for the sensible diminution of late years in the waters of the Volga and other great streams, whose affluents rise in those very countries where large tracts are now drained. For our own part, we can scarcely refrain from thinking that the axe of the miner (for wood is the chief fuel of the Russian miners) has been the cause of the increasing drought; an opinion which we formed in the Ural Mountains, whence the Kama and the greatest feeders of the Volga proceed, and where the inhabitants complaining of the annual decrease of water invariably refer this effect to the clearing away of their forests."

Can any other result, then, be anticipated for similar districts in New South Wales, of which an example may be found in the neighbourhood of the Icely Copper Mine, near Orange, where every stick of available timber has been destroyed, and fuel cannot be procured for a distance of six or seven miles. [*See Appendix No.* 5.]

Africa has also furnished examples which must not be neglected. Mr. James Fox Wilson, whom I mentioned before, has stated with great clearness and many details the case of the "Water Supply in the Basin of the River Orange or 'Garriep, South Africa," in the Journal of the Royal Geographical Society, vol. XXXV, the perusal of which will confirm much that has been already stated.

He points out that a great change in the external physical characteristics of the entire region between the Orange and the 'Ngami Lake has taken place since the country was first explored by Europeans.

He says the traditions of the natives carry back these changes to more remote periods, "when the country was far more fertile and better watered than at present; when the Ku'ru'man and other rivers, with their impassable torrents, were something to boast of. Moffat says the accounts of floods of ancient times, of incessant showers which clothed the very rocks with verdure, and of the existence of giant trees and forests which once covered the brows of the Hamhona hills, are wont to be related by garrulous elders to the utter astonishment of their younger listeners. In those ancient days the lowing herds walked up to their necks

in grass, and, filling their owners' milk-sacks with rich milk, made every heart to sing for joy.

"But travellers have before their eyes, in the immense numbers of stumps and roots of enormous trunks of the Acacia giraffe, where now scarcely a living specimen is to be seen raising its stately head above the shrubs, and in the ancient beds of the dried-up rivers Matlaurin, Mashua, Molapo, and others—positive demonstration of the departed former fertility of the lands of the Bechuana nation. In fact, the whole country north of the Orange River, and lying east of the Káláhári Desert, presents to the eye of a European, to use the words of the missionary just quoted, 'something like an old neglected garden or field.'"

Mr. Wilson shows next that this effect cannot be due to cosmical changes, but to "the characteristics of the region and the customs of its inhabitants."

The natural aridity of the soil, and irregularity of the rains (chiefly thunder-showers), with some other peculiarities, concur to produce occasional, if not periodical droughts, and that of 1862 is described in terms that recall to mind our Australian droughts somewhat intensified, and might be taken to describe the latter. The picture drawn by Mr. Wilson is one which in its main features may be easily recognised, and these, I may add, are features of drought in all countries lying within certain geographical limits with similar geological features. And so it has ever been since history has been written; witness the facts mentioned prophetically by sacred writers, especially the author of the book of Joel, in his first chaper, verses 4, 7, 10, 11, 12, 17, 18, 20.

The visitation of 1866 brings to Mr. Wilson's recollection Dr. Livingstone's statements respecting the drought he experienced on the Kolobeng River, in the Bakwain territory, during the first years of his mission work.

He goes on to answer the question, "*Is there any cause, besides the interior position of the country and the natural aridity of the soil, which occasions the advance of drought?*" He puts in large capital type the following words—"WE ASSERT THERE IS," and adds—"*and that the effects of that originating cause are controllable, and indeed to a large extent preventable.*" He then again puts in large capitals this sentence—"THE NATIVES HAVE FOR AGES BEEN ACCUSTOMED TO BURN THE PLAINS AND TO DESTROY THE TIMBER AND ANCIENT FORESTS." The Bechuana, especially the Batlapi and neighbouring tribes, are a nation of forest-levellers, cutting down every species of timber, without regard to scenery or economy." We need not consider the purposes for which the timber is appropriated, but may take Mr. Wilson's conclusion as sufficient. "By this means the country for many miles around becomes

entirely cleared of timber, while in the more sequestered spots, where they have their outposts, the same work of destruction goes on. Thus, of whole forests where the giraffe and elephant were formerly wont to seek their daily food, nothing is now left but a few stumps of the camel thorn, which bear a silent testimony to the wastefulness of the Bechuana. * * * *

"It appears certain that the further we proceed westward from the mountains of Natal and Kaffirland the less becomes the amount of rain bestowed by the clouds. The more denuded of trees and brushwood, and the more arid the land becomes, the smaller the supply of water from the atmosphere. The greater the extent of heated surface over which the partially exhausted clouds have to pass, the more rarified the vapour contained in them necessarily becomes, and the higher the position which the clouds themselves assume in the atmosphere under the influence of the radiating caloric; consequently the smaller the chance of the descent of any rain on the thirsty soil beneath, and the more the short-sighted colonist and ignorant natives burn the grass and timber, the wider the area of the heated surface is made; the further the droughted region extends, the smaller become the fountain supplies and the more attenuated the streams, till they finally evaporate and disappear altogether. Thus the evil advances in an increasing ratio, and unless checked *must advance*, and will finally end in the depopulation and entire abandonment of many spots once thickly peopled, fertile, and productive."

"In the case of the fountains at Griqua Town as having formerly poured forth an abundant supply of water, the accidental destruction of whole plains of the wild olive tree by fire near the town, and the removal of the shrubs on the neighbouring heights, are known to have preceded the diminution of rain, and subsequent diminution of springs, the subterranean caverns which acted as reservoirs in the bowels of the earth ceasing to be supplied from the clouds. There can be no question that, hitherto, vegetation, like animal life, has, in South Africa, been wastefully and ignorantly destroyed, in direct violation of physical laws, which can never be broken with impunity; and if we compare what is now taking place there with what has transpired in other arid countries, our conviction must deepen that it is not so much to the waywardness of Nature as to the wilfulness of man that we must assign the recent extension of the Káláhári Desert."

To those remarks the author adds references to other regions beyond Africa, some of which have not yet been mentioned by myself. For instance he names a case (mentioned in Chambers's Journal, July 4, 1863), where 400 springs in one small province of Persia, had failed; "the fatal consequence of permitting the

destruction of timber for fuel without making provision for a fresh growth."

He cites also "the British Colonies of Barbados (1), Jamaica (1), Penang (2), and the Mauritius (3) [see for the latter the note below*] where the felling of forests has been attended by a diminution of rain." The Punjaub, the Dekkan, Steppes of Tartary, Algeria, Texas, New Mexico, testify the same fact in all parts of the earth, that "trees are the true rain-makers." "But," he says, "we must not stop here, the evil is of such magnitude, and likely to bear so abundant a harvest of misery in the future, that the authority of law, wherever practicable, should be invoked, in order to institute preventive measures.

"Not only should fuel be economized, but the real interests of the British Colonies, for many long years to come, would most certainly be consulted by the passage of stringent enactments which should, in the first place, forbid, at any season and under any circumstances whatever, the firing of grass on field or mountain. Those Colonial Acts on this subject are not sufficiently stringent to be of much service."

In conclusion of his paper, Mr. Wilson points out the necessity of re-planting, and introduces among the trees recommended for planting along the courses of rivers by the late Dr. Harvey, Professor of Botany at Dublin (whom I remember to have seen in this Colony on a visit), some of the dwarfer and more leafy *Eucalypti;* and suggests the formation in ravines of artificial reservoirs and damming of watercourses as in Australia, recommended by Mr. Francis Galton. To this I would offer the further suggestion of planting near such reservoirs, as it is now discovered that such reservoirs as the Yan Yean for instance, if repeated, would collect all the drainage of a country only to expose their surfaces to greater evaporation than the water was subject to in its natural channels.

Speculation has recently turned its conjectures as to the possibility of creating a new inland sea in Northern Africa. In an abstract of a report relating to it, written in August last,

(1) Phil. Trans. II. 294. (2) Journal of Indian Archipelago. (3) Thornton's History of India. (4) Baude's Algeria. 78–81.

* The following is a report from the Mauritius correspondent of the Sydney *Herald*, published in the *Echo* of 25th July, 1876:—

"The Legislative Council has had its usual number of sittings during the month. At one of the last of these the subject of re-wooding the island by the purchase by Government of land and planting of forest trees was again brought on the tapis.

Our forests have been ruthlessly destroyed, in some cases with the object of planting sugar-canes, and in others with the mere view of selling firewood, and now the result is apparent in continual droughts, and in the disappearance of the streams which were formerly abundant in every part of the island."

we find the following remarks, showing the effect of forest destruction in creating a desert:—

"Vice-Consul Dupuis, in his report this year on the trade of the port of Susa, Tunis, makes remarks on the subject of the project for submerging the region of Djerid by constructing a canal at Gabes, and so creating an inland sea. He considers that the recent surveys confute the idea of their having been formerly a connexion with the Mediterranean, and of the choking up of the passage for the waters, an idea perhaps based upon the inferiority of level to that of the sea; but in his opinion the observations made seem to endorse the fact of all the region having been under water. Arab writers unite in describing the country at the date of their conquest as having been very wooded and abundantly supplied with streams of water. The wood was cut down to facilitate the subjection of the tribes, who for above a century fought desperately for their independence, and whole regions are now condemned to sterility (save, perhaps, an oasis here and there), which were formerly rich in pastures, and interspersed with towns. The desert has been gradually extended in the district between Tripoli and Egypt, covering parts once fertile, and has in like manner encroached on the Tunisian southern frontier between it and Tripoli. The diminished heights and lowering of the Atlas let in the sands driven by the southerly winds, to which the more elevated and uniform heights of the mountain system oppose a barrier in more favoured Barbary States westward. In Morocco these winds are so tempered in their passage across the intervening heights as hardly to be recognized as the same which in Tunis dry up and parch the land in summer. Their action upon the sands accumulated by them at the foot of and in the passes of the mountains southward, where they sink into the plain, is the same as that seen at street corners, but on a large scale, and the sands are whirled and spread over the southern provinces. A form of this indraught and encroachment is seen in the winds which predominate in the fall of the year and fill the air with a minute and impalpable sand, very injurious to the sight; this sand, on examination of collections of it, is found to be very fine, while that around and in the valleys generally is coarse, the one being foreign or sands drifted from long distances, and the other indigenous or formed on the spot. It is presumed that the disappearance of the waters is due to the encroachment of the desert caused by the action of these winds during a long succession of centuries, aided by absorption and by evaporation occasioned by the presence of the vast scorching desert on the south, and also by the substances brought down by streams diminishing the depths and spreading the waters, and thereby helping in the work of desiccation. This was accelerated also by a decrease in the

water supply in consequence of the disappearance of mediæval forest, cleared away by the Arabs on and after their conquest. Hence the periodical rains, which once fertilized the country, have been replaced by heavier but rarer falls, which rush down the slopes and disappear in the sands or mix with the noxious waters of the lagoons before they can saturate the soil to any depth, washing away the earth and exposing naked rock on hill sides or high grounds."

We shall further gain considerable information by also considering the evidence offered by the East Indies :—

One of our recent Governors, Sir William Denison, whilst Governor of Madras, wrote thus to Sir Roderick Murchison, on 17th October, 1861 :—"On coming down by the railway to the west coast we passed through a gap in the Western Ghauts, about forty miles in width and 1,200 feet above the sea. The Neilgherries rise 8,500 feet to the north of this ; the Anamullays 6,000 to 7,000 feet to the south. The space between is a brown dry plain. After passing over about twenty miles of this, on a gradual descent, we, all of a sudden, plunged into the richest possible tropical vegetation, there being no change in the soil. On inquiring into the cause of this, I was told that the line of jungle marked the limit of the south-west monsoon, but why the monsoon should stop there I cannot tell. People informed me that a quarter of a mile was the amount of disputed territory between moisture and drought ; that I might stand at one place and get but a slight sprinkling of rain, while a movement westward of a hundred yards would bring me into a tropical downfall. I have seldom seen anything which struck me as more remarkable. Why should not the wind sweep the rain up the plain, seeing that it has brought it thus far ? I am dealing in questions, but in point of fact, these apparently trifling questions are most difficult to answer."—(Varieties of Vice-regal Life, vol. II., p. 131.)

Whether Sir Roderick was able to give, or did give any answer to the question does not appear in the correspondence printed in the book quoted from ; but the question is not without answer, for with no direct allusion to Sir William it has been made in a valuable account of the "Effects of Forest Destruction in Coorg. By George Bidie, M.D., &c. ;" read before the Royal Geographical Society of London on 25th January, 1869, and published in the 39th volume of the Society's Journal.

Coorg is near the centre of the western Ghauts, and not very far from the Neilgherries. The height of 5,000 feet is attained by the crest of the hills, to the east of which the country consists of low long-backed ranges with deep valleys, gradually subsiding in the table-land of Mysore, the average elevation being 3,000 feet. The Cauvery River runs through in a wide

basin with but little forest, but it is considered that formerly forests covered the whole province. It is still dense and lofty to the westward, and continues so for 10 miles from the crest of the Ghauts, whilst at 12 miles occurs the bamboo district, with smaller and more open jungle. Dr. Bidie says: "The nature of the forest, and also the kind of the trees found in it, form pretty accurate indices of the amount of rainfall." By a subjoined table by Mr. Richter, of Verajendrapetta, I find the means of seven years calculated monthly give a general mean of 111·66 inches of rain, with a temperature for four years of 66° 38 F. But Dr. Bidie states that in the dense jungle tract the rainfall varies from 120 to 150 inches, and in the bamboo district from 60 to 100 inches; whilst in two or three months, in January, February, and March of each year (according to the table) none falls. The characteristic trees in the dense jungle are—Michelia, Mesua (ironwood); Diospyros (ebony and other species); Calophyllum angustifolium; Cedrela toona (white cedar); Chickrassia tubularis (red cedar); Dipterocarpus, Garcinia, Artocarpus, Canarium strictum (black dammer tree); Euonymus, Cinnamomum iners, Myristica, Myrtaceæ, Vaccinium, Melastomaceæ, three species of Rubus, and a Rose. In this forest there is a dense undergrowth of moisture-loving plants, with splendid orchids on the branches of many of the trees. The bamboo tract is somewhat different, the line of approach being marked by the absence of ferns and the prevalence of a small Ardisia. The bamboos send up their branches in all directions, and in the eastern portion are teak and sandalwood. This forest is not continuous, but has grassy glades, and under the shade are good pasture grasses and gay annuals in the rainy season.

The rain in Coorg is almost entirely derived from the south-west monsoon—chiefly between 1st June and the end of September. The winds come loaded with rain, which deposit their freight on the Ghauts and the lower regions to the west. This rain is from condensation of the warm ocean vapour on the colder hills; and Dr. Bidie says there can be little difference whether the mountain slopes are bare or clothed with dense forest. He regards the forest on the high lands not as the parent, but as the produce of the rain, as the latter diminishes to the eastward.

As no regular records have been kept for the last fifteen or twenty years, he says there is not sufficient evidence to support his opinion that "the annual rainfall can be sensibly diminished by the destruction of the forest that has taken place." Yet the natives complain that their country of late years has become hotter and drier from want of rain, and that rice crops have been diminished or lost from failure of water in streams that used to run throughout the year. These changes they attribute

to the cutting down of forests on coffee estates; and, therefore, he proceeds to "inquire what effects the destruction of forests actually may have had on the climate and streams of the country."

He is led to admit that it is only twelve years since the felling of the forests in Coorg has taken place extensively, and that the effects are only gradually perceived, but do go on till they acquire a disastrous power. In Coorg there are 20,000 acres denuded of forest to make way for coffee, and the clearings are partly in the bamboo, chiefly in the dense jungle tracts. These clearings are along the banks and crests of low hills and the slopes and passes, which are densely wooded, and well supplied with springs, forming numerous streams. He then shows how these streams percolate the soil and are preserved by the forest and the matted soil. At the same time the shade of the forest prevents evaporation, the trees exhale much, and a portion is returned in dew or fog to be wafted away.

His information, during his tour in Coorg and Mysore, convinced him that "the facts elicited on the whole go to prove that the tropical forest is the *alma mater* of springs and streams. "Various instances," (he says) "have been brought to my notice of springs and small streams having become quite dry since the forest was cleared away in their neighbourhood, while in numerous cases those that used to be perennial only contain water now during and for a short period after the monsoon. Similar results have been found to follow the destruction of forests growing near the source of streams in all parts of the world." He next shows from Major Sankey's report on public works in Coorg for the official year 1865-6, that "great damage has been done to roads and bridges resulting from forest clearance, by the removal of the binding influence of tree roots to keep the banks" of the nullahs in position.

The remainder of Dr. Bidie's paper is occupied by reasoning to show the injury to the atmosphere, producing malaria and increase of heat, the forest always breathing "soft land airs" from the jungle, and to "these land winds is due the coolness of the nights, which will generally admit of sound slumber"; and in these words he quotes from Cameron, on the Tropical Possessions in Malayan India,—"That the cutting down of forests in Coorg has rendered both earth and air drier is shown by perennial streams having become periodical, by many plants perishing that used to flourish during the dry season, and by other remarkable changes in natural phenomena. He finally points out the effects of clearings on animal life, and the introduction of new and troublesome plants from other regions."

To complete the evidence from that portion of India alluded to by Sir Wm. Denison and Dr. Bidie, we must, in conclusion, turn to the valuable dissertation of Mr. G. S. Markham, F. S. A., Secretary to the Royal Geographical Society, "*On the Effects of the Destruction of Forests in the Western Ghauts of India on the Water Supply*" (published in the Society's Journal, vol. XXXVI., 1866).

The author introduces the district of Coorg, but does not confine himself to it. He says: "The destruction of forests has been one of the chief agents in effecting changes in the earth's surface, and the best methods of counteracting evil which may be caused by these extensive clearings is one of the most important questions that occupy the attention of physical geographers." This agent is now at work in the Western Ghauts of India, those rich and beautiful mountain-districts forming the backbone of the Indian Peninsula, and containing the sources of a water-supply on which the prosperity—indeed, the very existence—of millions depends." It is of an area of fully 7,000 square miles, to which the above remark refers; and it includes Wynaad plateau, which to the south borders Coorg, and is about 50 miles from the feet of the Neilgherries.

Wynaad is drained to the eastward by rivers that join the Cauvery; these are fordable in the dry season, and become furious torrents, 200 feet wide, rising thirty feet, dashing along with tangled branches and uprooted trees. In these respects they form a parallel to the rivers of Australia that descend from similar average height of 3,000 feet; the rocks are hornblendic granite and syenite, with basalt and quartz.

Coffee-planting commenced in 1840, and in 1866 there were 192 estates, covering 14,613 acres.

Passing the gap, mentioned by Sir W. Denison, in which the railway runs, rise "the glorious Anamullays and Pulneys, and the hills of Travancore, and these run on with breaks and peaks, under various designations, to Cape Comorin. The Pulneys were described by Mr. Markham, in his "Travels in Peru and India." The Anamullays were described by Dr. Cleghorn.

The rainfall on the Ghauts which is given above as about 112 inches, according to Mr. Markham decreases towards the south from 248 inches per annum at Mahabuleshwar, near Bombay, to 65 at Trivanderum, and to 30 inches at Cape Comorin.

At Mercara, at the centre of Coorg, it is 145 inches; at Nuggur, about 100; the mean of Nuggur, Coorg, Wynaad, and the Koondahs "receiving the whole force of the monsoon" have a rainfall of 200 inches; the aspects giving at Chumbra hill to the west 186 inches, and a few miles to the eastward 154.

On the highest peak of the Neilgherries, from 1847 to 1865, the average annual fall was 86·13 inches, the maximum being

102·83 in 1847, and the minimum 65·99 in 1848. "Although the rainfall thus varies according to local circumstances, every particle of moisture is wrung out of the clouds in their passage from the Indian seas by the intervention of the mountains;" and so far as this is the case, "the forests," says Mr. Markham, "which clothe their sides and fill the valleys and ravines on their plateaux, have the effect of regulating the flow of water to the eastward, but I cannot see that their presence or absence can have any influence on the actual amount of rain which falls on the hills." Of course this is sound reasoning, applicable to all very lofty mountains, whether in India or Australia, and probably so long as the primeval forests remained the supply in the rivers would continue at the usual average amount in a series of years. This consideration meets the argument that though in New South Wales the smaller streams have been partially or nearly altogether dried, as in the Illawarra, yet in the larger rivers, where at present the forests at their sources or on their banks have not yet been destroyed, the apparent body of water may be nearly the same as of old, though this is altogether conjectural in the absence of past or present measurements.

But the argument itself "*will not hold water*" any more than the river channels when destruction of the regulating forests is taken into account. Let us attend to the eye-witness before us. What, after his admissions, does Mr. Markham say?—

"The settlement of planters on the hills has given rise to wide-spread destruction of the primeval forest. The planters are occupied chiefly in the cultivation of coffee, to which has been recently added tea, and the quinine-yielding cinchona of South America. These three products give rise to the felling and clearing of forests in the formation of plantations—making a total of 60,000 acres of forest destroyed. Nor has the process by any means reached its limit, and a great change is taking place in the physical condition of the hill districts.

"One obvious consequence of the destruction of the forests is an increased rapidity of surface drainage, giving rise to sudden and destructive floods at the outlet on the plains, where the change of slope causes a diminution of velocity, and to injurious freshes in the irrigating rivers after they have reached the plains."

"The effect of vegetation is undoubtedly to retard elevation and to check the rapidity of drainage; and the removal of forests of course has an opposite effect. The hill districts of India are now affording proofs of this law of Nature. The floods caused by the monsoon rains are yearly increasing in size and violence." He gives several instances, and adds: "All this is clearly due to the extensive clearance of forests, owing to which the rain-water rushes off the surface instead of sinking into the earth and

forming springs." Again: "Major Sankey is of opinion that the original form of the hills may be permanently altered. The only remedy seems to be to preserve a broad fringe of trees and bushes above the road. Equally disastrous consequences arise from clearing below the roads which pass along a mountain side." * * * "Major Sankey, therefore, strongly urges the necessity of preserving a belt of jungle both on the upper and lower slopes of a mountain road. For the last twelve years a system of forest conserving has been established in the Madras Presidency, under the able and zealous superintendence of Dr. Cleghorn, with a view mainly to the preservation of valuable timber and of firewood, and to the retention of belts of forest near the sources and along the courses of streams. The construction of public works is by far the most important part of our mission in India, and their completion will form the chief, if not the only, justification of our occupation of that vast empire. As a branch of the Public Works Department, a forest agency is very necessary, both for the supervision of felling and planting on a proper system, so as to ensure an adequate supply of timber for public works and of fuel for railways, and for the conservancy of forests, to obviate the disastrous effects of indiscriminate felling on bridges, roadways, and irrigation works. * * * * * * * * * *

"It must be remembered that one of the three products, the cultivation of which is now extending so rapidly in the hill-districts, will have the effect in a few years of supplying the place and performing the functions of the original forest. The beautiful foliage of the cinchona-trees, which after four years of growth are 20 feet high, will be as effective as the trees they have supplanted in preventing evaporation, regulating drainage, and receiving the moisture which is wrung out of the passing clouds. * *

"In the end of 1866 there were upwards of 1,500,000 cinchona-plants in the Government plantations on the Neilgherry hills, besides many others under cultivation by companies and private individuals. It is the intention of Government to plant 1,200 acres with cinchona-trees, and to keep another 1,000 acres as a reserve for further planting, if it should be considered desirable hereafter. * * * * * * * * *

"Still many square miles will be bare which once presented an unbroken surface of foliage. The forests will to a great extent disappear, and it is necessary that some other agency should be found to perform their duties, which are those of regulating and economising the drainage of the rain-water. * * * *

"It must be remembered, however, that the destruction of forests is very far from having reached its limit, that the rapid surface-drainage caused by it already effects much mischief in

the hill districts, and that as the felling proceeds these consequences may eventually be felt even in the Cauvery delta." * *

He suggests "the extensive planting of cinchona, teak, cork, vengay, black-wood, *Australian* and other valuable trees"; and concludes with naming other countries in which destruction of forests has been attended with injury. He quotes the Ural in Russia, Curaçoa in the West Indies, Hissar in Northern India, and the Orange River, in Africa, giving the names of reporters on each.

The preservation of forests in the *Northwest Provinces of India* was also long before the dates last-mentioned subject of earnest inquiry. The late Dr. Falconer, Colonel Cautley, and others, addressed the Government as to the necessity of active interference, and succeeded in inducing some vigorous measures for repressing the evil; so that for nearly forty years the value of forest vegetation has been recognized, and its reckless destruction condemned. In closing my argument, I think I needed nothing more satisfactory than the proofs furnished by Dr. Bidie and Mr. Markham, of the "Effects of Forest Vegetation on Climate," and of occasional injury by its Destruction.

But before I conclude, it may be useful to offer a few practical remarks as applicable to this Colony; indeed, I should be surprised if some of the preceding remarks had not already been accepted in that direction.

Not wishing to leave the question undefended or without satisfactory evidence as to its truth, I have endeavoured to strengthen my own conclusions by calling in a host of witnesses, who have shown by examples gathered from the East and West Indies, North and South America, Northern and Southern Europe, and Africa, that "Forest vegetation" has considerable effects on what in the extended sense is called "Climate"; that it exerts a protecting influence as well as an assisting power in preserving and increasing the supply of water, and that it is of vast importance to an arid region that such an influence should be encouraged and maintained.

Partly from these considerations, as well as from motives of a commercial kind, Commissions have been appointed and Legislation called into play, in some of our Australian Colonies, and in various other countries, especially in British India, for the conservation of the Deodar and other forests, and this has been a subject of discussion for a quarter of a century. (See Dr. Cleghorn's notice in British Assoc. Reports for 1865, p. 79.) Now, there are many circumstances connected with climate in this Colony which seem to parallel some of those which distinguish the physical character of India in relation to its floods and droughts. It may appear singular, but it is held by many close

observers and by hydraulic engineers, that floods are sometimes occasioned by the destruction of forests, as I have intimated already in allusion to Dr. Bidie, who holds the opinion that under certain conditions such clearings greatly extended will produce effects far beyond their immediate limits.

The peculiar vegetation of Australia, its geological structure, and the nature of its rocks and soils, may seem to be exceptional; but its droughts and floods have much in common with those of other countries where the physical conditions are not widely different: and even should our tentative conjectures as to periodicity ever become established facts, we should have then something more, and that something more reliable, to rest upon in our endeavours to benefit the natural conditions of our climate. The very close resemblance between it and that of Palestine justifies a brief quotation from Dr. Tristram's work on the "Natural History of the Bible." He says, "There is every probability that when the country was well wooded and terraced, and those terraces clad with olive trees, the spring rains were more copious than at present. Many light clouds which now pass over from the west would then be attracted and precipitated in rain over the highlands. At present, without any effort to utilize the bountiful supplies of Providence, three-fourths of the rainfall are wholly wasted." (p. 33.)

Is not this equally true respecting even those parts of this Colony that enjoy the greatest abundance of the "former and latter rains" in their season?

Ought it to be allowed, that in addition to neglect, there should be added wilful waste?

It has been my privilege at one time or another during my various journeyings to visit the sources of almost every important river and stream in this Colony, and it was not without some dread of the future that I have seen the possibility of the country becoming greatly deteriorated as to its water supply. At a time when the whole community is, or ought to be, excited as to such supply, would it not be wise in the Government and Legislature to make provision against wilful destruction of the woods and forests that border the courses of our rivers; to prevent clearing and ring-barking, except under regulations, the latter, as some times practised, being one of the most suicidal of schemes for the injury of posterity, as will be found, perhaps, at no distant date?

It may be said that our clearings bear but a small proportion to the timber that is left; but the difference increases in a geometrical ratio, and as population continues to arrive and spread, the land will gradually lose its protection of forest vegetation, and become year after year more and more arid and waterless. This, let us remark, is independent of effects from

the trampling of flocks and herds. Having noticed that many of our streams and rivers rise in swamps that lie in hollows of our hard, fissured, and dry rock formations, I ventured, in my Report to the Government, in October, 1851, to suggest that "it would be worth the attention of the Legislature, how best to preserve the integrity of the swamps," "satisfied that the greatest injury that could be inflicted upon the pastoral and other rural occupations of the colonists would be the introduction of the system of swamp drainage."

Perchance some may think it to be a stepping out of my proper province to repeat that warning, and may remind me of the old saying, "*Ne sutor ultra crepidam.*" But something is required to be done at once if our waters are to be conserved for times yet future, when manufacturing industries will extend. Not only ought the present destruction of timber that goes on in various parts of the country to be checked and regulated by law, but provision should be made for the replanting of many a naked tract of former forest vegetation. I might appeal to the Surveyor General on this subject, as he well knows that in some of our auriferous areas the whole of the timber has been ruthlessly cleared away. Similar practices have been employed by diggers in Victoria, and large areas have been completely denuded without any replanting, much (as I believe) to the vexation of that eminent botanist and public friend of the sister Colony, Baron von Mueller, whose labours in botanical science have earned him a name surrounded with enduring respect.

The views expressed by that learned and ever-active philosopher, in one of his elaborate treatises on Australian vegetation, fully bear out the testimony offered by so many other independent authorities as to the effects of "lofty and wooded ranges originating springs and rivulets for the formation of larger rivers." Nor is his language too enthusiastic when he says:—"On this I wish to dwell—that in Australian vegetation we probably possess the means of obliterating the rainless zones of the globe; to spread at last woods over our deserts, and thereby to mitigate the distressing drought, and to annihilate perhaps even that occasionally excessive dry heat evolved by the sun's rays from the naked ground throughout extensive regions of the interior * * * * * Even the rugged escarpments of the desolate ranges of Tunis, Algiers, and Morocco might become wooded; even the Sahara itself might have the extent of its oases vastly augmented; fertility might again be restored to the Holy Land, and rain to the Asiatic plateau or the desert of Atacama, or timber and fuel be furnished to Natal and La Plata. An experiment instituted on a bare ridge near our metropolis (*i.e.* Melbourne) demonstrates what may be done." The Baron

suggests in this not the indiscriminate clearing or ring-barking of trees, but "the mere scattering of seeds of our drought-resisting Acacias and Eucalypts and Casuarinas at the termination of the hot season along any watercourse, or even along the crevices of rocks, or over bare sands or hard clays after refreshing showers." Surely this would be far better than sowing the seeds of thistles, as was done years ago by one of the early settlers wherever he went—the origin of so much injury to his successors.

The paper from which my extracts are taken is one of the "International Exhibition Essays" of 1866–7, and will well repay a careful perusal. Nor is our New South Wales botanist of celebrity, the Rev. Dr. Woolls, less clear in the sound opinions he expressed in his recent lecture to the Horticultural Society of Sydney, not two months ago. He then pointed out in unmistakeable terms the mischief done to the community and to individual landed proprietors by the careless destruction of the forests, and the "murderous process" of ring-barking those wonderful *Eucalypti* which the providence of the All-wise Creator has planted in the great Australian garden—living types, as it were, of a tree "the leaves of which are for the healing of the nations"—and which, though too often foolishly rooted out or suffered to stand ghastly monuments of the covetousness of Australians, have found favour in Spain, in Italy, in America, and Northern Africa. Indeed, I now call to mind that the very first assemblage of living Australian trees that I ever beheld was in the plantation of a Dutch Baron in Southern Africa.

Showing the extent to which this practice is carried, we may find in the *Sydney Herald* of this very morning mention of seventy Chinamen employed in ring-barking on a single run, near Albury.

Respecting the value put upon the growth of *Eucalypti* in other countries, I need only refer to a volume published in San Francisco, entitled "Forest Culture and Eucalyptus Trees, by Ellwood Cooper, 1876," in which he repeats the substance of many of the publications of Baron von Mueller, and strengthens them by references to other writers. [*See Appendix No.* 6.]

Surely, whilst in other lands Australian trees are considered of so much importance as to have been dignified with the title of "The Trees of the future," it does seem strange that in Australia they should be held of comparatively little value.

So far as our water supply is concerned, a whole code of provisions is required, and the establishment of officers who in this Colony should have the same duties and powers as belong to the Conservators of woods and forests in other parts of Her Majesty's dominions, and in foreign countries also.

The Director of the Botanical Gardens could furnish a list of such trees and plants as would protect and encourage the water

supply of our rivers, and perhaps assist the elements in gradually ameliorating the severity of such a drought as many of our brethren are still passing through; for though we have been blessed on part of the sea-board with refreshing showers, there are even now thousands of sheep travelling in search of grass and water, while most of the runs throughout the country are occupied to their full capacity.

There are also spots along our coasts which should be planted to prevent the inroad of drifting sand. The cutting down of a natural scrub on the cliffs of Newcastle was followed by an inroad of sand which maintains its position; and a graveyard near Wollongong has been partially if not completely covered with sand, as is the case in numerous places on the eastern coast of England, and of which there are given some excellent illustrations in the late Sir Charles Lyell's "Principles of Geology" (vol. I., chap. 20).

The late Dr. Mitchell has been heard to say that, on his arrival, in the Colony, the sands that now exist as formidable dunes between Sydney and Botany had scarcely advanced beyond the shore. Should they continue their march, the flood of sand may threaten the burial of as many buildings as lie hidden beneath the undulating wastes of the Atlantic coast of France; but they, and even the sand-hills of Central Australia, may be made to obey the same law as the billows of ocean itself—"here shall thy proud waves be stayed"—by the careful and well directed employment of the means furnished by Him who gave that command of old; for Man, to whom the dominion of this lower world is given, is able by the simple use of natural contrivances not only to protect the flowing streams of water, but to shackle and enchain the desolating floods of harder material that have entombed churches and houses, and driven out inhabitants of many a seaside town and village in Europe.

If any apology be needed for introducing at such length the subject just discussed, let it be pleaded in the words of the poet:—

> Rura mihi et rigui placent in vallibus amnes
> Flumina amem, silvasque inglorius * *
> * * O! qui me gelidis in vallibus Hæmi
> Sistat et ingenti ramorum protegat umbra;
> Felix, qui potuit rerum cognoscere causas.
>
> [Geor., ii., 485.]

APPENDIX.

The main portion of this paper having been struck off, before I had time to introduce some additional matter which I had intended to incorporate therewith, it has been deemed advisable to introduce it under several heads in an Appendix, together with the meteorological observations of the Rev. L. Guilding, in St. Vincent's Island, West Indies, mentioned in the text.

No. 1 (p. 2).—Ring-barking.

This process is defended on the ground that it enables a little more grass to be grown at the roots of trees that are dead, and that it does no harm to clear away useless scrub. Unfortunately, however, it is proved (See Chambers's Journal, part 153, Sep. 30, 1876, p. 591) that gum-trees do not lessen but assist the deep supplies of water; and the objection I have expressed is not to the clearing off of useless timber, but to the destruction of iron-bark and others of our most valuable timber-trees, evidence of which is easily collected, not only from the dead forests of thirty or forty years existence, but from what is still going on in hundreds of fresh localities. At present no statistical returns have been made; but it would be useful to know how many thousands of acres have thus been disfigured, and what is the annual rate of destruction, and in what ratio the evil has been counteracted by re-plantation. Might not these be fit items in the Registar General's annual Returns?

The time is fast approaching when the future occupiers of land that cannot for ever be held as much of it now is, will be loud in their complaints respecting wood for fencing, bridges, railway-sleepers, and other wood-consuming ingenuities, to say nothing of fuel, where coal is not, and the demands of mining industries, which are insatiable, will be loud in denouncing the want of foresight in their predecessors.

The clamour has already been begun, and it will not cease till it makes itself unpleasantly heard.

No injustice is intended to the sheep-farmer by such remarks as these. But sheep-farming may be carried on without injury to the forests, by the act of re-planting judiciously to compensate land now injudiciously laid bare or disfigured by some who are killing the bird that lays the golden egg.

No. 2 (p. 11).—Use of Forests.

Let us notice what a writer in a popular English work (edited by William and Robert Chambers) entitled "Information for the People," 5th edition, 1874, on Arboriculture (vol. 1, p. 593) has

to say on the subject. "Arboriculture, or the cultivation of trees and shrubs, is one of the most interesting and important of the rural arts. It is a branch of industry which is daily becoming a subject of great national importance, not only as regards Britain, but also her Colonies and Indian Empire. Science has proved that the cultivation of trees and shrubs exercises a most benign influence on the climate, and on the health and death-rate of a country, as well as on its prosperity. Hence more attention is now being paid to the better conservation and management of forests, both at home and abroad. While agriculturists are continually carrying on a warfare of extermination with the straggling hedgerows of scattered trees that are yet common in many of the finest cultivated districts, they are fully alive to the importance of the shelter derived from trees when properly arranged on the exposed parts of their fields, or around their homesteads; whilst the profusion of trees and shrubs cultivated around suburban and villa residences, as well as in town squares and public parks, clearly shows how much agriculture is an object of delight and pleasure to the people. * * * * *

At no former period has the demand been so great as during the present century. Within that period the landscape of Great Britain has undergone a complete change, and many of her bleak and barren hills and waste lands are now covered by thriving plantations. Thus the adjoining lands have become more fertile and valuable, and the food production of the country has thereby greatly increased."

In Messrs. Chambers's Journal, part 153, Sept. 30th, 1876, will be found an essay "On the use of Forests," which may be cited as bearing direct testimony to the truth of the views maintained by myself. The author points out four distinct effects of forest vegetation on climate and rainfall, and shows how theory and experiment agree. The facts and reasoning employed in this paper would have been quoted in the text if they had fallen under my notice before it had been committed to the press.

No. 3 (*p.* 12).—*Water from Plants.*

We have the testimony of the late Commodore Goodenough to a similar fact in Figi. He says in his Journal (Dec. 10, 1873): "Walked up to the top of Ovalu. * * * It is not much over 2,000 feet, but very steep and rugged; in some places a climb hands and feet up the face of a rock. The foliage is beautiful as always. In one place a sort of strong creeper grows as thick as my wrist; one cuts off a foot of it, and on squeezing it out come several good mouthfuls of pure, clear water. At another place a lot of tall leaves collect water and carry it down the juicy stem of a tree which is, to look at, like a banana. One pierces the stem at the junction of the stalk of the big leaf, and

out comes a jet of pure water. The buds of the wild ginger hold water too, but not so much, and it has a decided taste. And all this is not in the ravines, but on the ridge along which we walked all the time." (p. 211).

No. 4—St. Vincent's.

The following tables of temperature and rain fall in St. Vincent's, during the period mentioned (at p. 18) from 1823 to 1829, were forwarded to me in 1835. They have never been published till now. With them came a memorandum which I here copy. "From the little variation of the temperature there is much deviation from the laws observed in more variable climates. Our plants are less affected by the seasons than by the soil, the elevation and the exposure, and are therefore developed without regularity The Demerara Indians are said to date the progress of their seasons from the flowering of certain plants, commonly known. I have before mentioned the fall of rain in St. Vincent; a journal of the Barometer would be of little interest. Its range on the coast is very trifling, and the column will remain for weeks without altering the convexity of the mercury. However, when taken to the summit of mountains it experiences very extensive changes, and accordingly I have been able with one of Dollond's instruments to measure our higher lands with all the necessary accuracy. On the coast of St. Vincent, the instrument rarely foretells anything but some violent hurricane."—[L. G., May 1, 1830.]

1823.

General Account for the past Year, 1823.

Month.	Thermometer.						Pluviameter.		Charaib Country	
	In Charaib Country.			In Kingstown.			Quantity of Rain, in inches.		Number of dry days.	Number of rainy days.
	Lowest at Sun-rise.	Highest at Noon.	Average.	Lowest at Sun-rise.	Highest at 2 p.m.	Monthly mean.	Kingstown.	Charaib Country.		
January	70	80	75	73½	82	78·68	3·36	3·27	19	12
February	74	80	76¾	75½	84	79·37	0·39	0·84	18	10
March	68	81	75	74	85	79·16	1·25	3·67	20	11
April	70	82	76½	74½	87	80·55	1·35½	7·50	18	12
May	75	83	77¼	76½	88	82·41	6·03	4·33	14	17
June	75	83	79	77½	87	82·31	7·33½	12·24	2	28
July	76	82	78	78½	86½	82·00	10·70	11·33	10	21
August	74	84	77½	78½	87½	82·54	4·57½	8·78	11	20
September	75	84	78½	79	88	82·83	7·66	6·31	8	22
October	75	84	80	76	88	83·07	4·01½	6·52	14	17
November	74	83	78½	76	86	80·78	16·75	14·29	8	22
December	71	82	76¾	75	86	79·52	5·56½	3·57	15	16
Year	73·08	82·33	77·39	76·20	86·25	81·10	68·99	82·65*	157	208

* The quantity of rain which fell in 1822 was 120·14 inches, being 37·49 inches more than last year. The number of wet days in 1822 were 261, and of dry days, 104.

1824.

General Account for the past Year, 1824,

Month.	Thermometer. In Charaib Country. Lowest at Sunrise.	Thermometer. In Charaib Country. Highest at Noon.	Thermometer. In Charaib Country. Average.	Thermometer. In Kingstown. Lowest at Sunrise.	Thermometer. In Kingstown. Highest at 2 p.m.	Thermometer. In Kingstown. Monthly mean.	Pluviameter. Quantity of Rain, in inches. Kingstown. 1823.	Pluviameter. Quantity of Rain, in inches. Kingstown. 1824.	Pluviameter. Quantity of Rain, in inches. Charaib Country. 1823.	Pluviameter. Quantity of Rain, in inches. Charaib Country. 1824.	Charaib Country. Number of dry days.	Charaib Country. Number of rainy days.
January	70	81	76¼	75	84	79·41	3·36½	3·81	3·27	2·88	18	13
February	74	81	77¾	74	85	79·29	0·39	3·04½	0·84	2·89	11	18
March	74	82	77¾	74	86	79·37	1·25	3·64¼	3·67	3·39	18	13
April	75	82	78	76	87	81·63	1·35½	2·72¾	7·50	2·70	16	14
May	74	82	77¾	76	86	81·14	6·03	10·07½	4·33	7·71	11	20
June	74	84	78	77	87	81·73	7·33½	13·19	12·24	10·82	9	21
July	76	84	78¾	77	86½	81·95	10·70	8·95½	11·33	9·61	10	21
August	76	84	79½	78½	88	82·44	4·57½	9·69½	8·78	13·11	8	23
September	82	80	81	79½	88½	83·53	7·66	6·24½	6·31	8·78	8	22
October	72	85	78¾	76	88	82·08	4·01½	11·95½	6·52	8·98	6	25
November	73	83	78	75	86½	81·43	16·75	6·58	14·29	7·05	10	20
December	68	84	77¼	73	85	79·23	5·56½	5·58	3·57	13·65	15	16
Year	74	82·66	78·23	75·91	86·46	81·10	66·99	85·50	82·65	91·57	140	226

1825.

Month.	Thermometer. In Kingstown.			Pluviameter. Quantity of Rain, in inches.					Charaib country.	
	Lowest at Sun-rise.	Highest at 2 P.M.	Monthly mean.	In Kingstown. 1824.	In Kingstown. 1825.	At Langley Park. 1824.	At Langley Park. 1825.	At No. 14. 1825.	No. of dry days.	No. of rainy days.
January	75½	85½	80·17	3·81	3·18	2·88	4·15	4·52	14	17
February	75	86	79·98	3·04½	2·16	2·89	1·76	2·82	18	10
March	75½	88	81·37	3·64¼	3·87½	3·39	7·67	8·79	13	18
April	78½	89½	82·46	2·72¾	2·80	2·70	13·69	14·95	10	20
May	77	87½	83·12	10·07½	5·63	7·71	11·34	12·54	11	20
June	79	88½	82·80	10·19	10·13½	10·82	11·20	8·45	6	24
July	79	87	83·18	8·95½	5·35	9·61	4·83	5·84	13	18
August	78½	88½	83·82	9·69½	5·81	13·11	5·37	4·85	14	17
September	78½	88½	83·56	6·24½	9·61½	8·78	7·10	9·77	8	22
October	76½	88	83·02	11·95½	8·67	8·98	17·45†	16·70	8	23
November	77	87½	82·11	6·58	11·82	7·05	15·35	17·80	11	10
December	72*	85½	80·95	5·58	9·90	13·65	8·34	9·80	9	22
Year	76·83	87·5	82·21	82·50	78·94½	91·57	108·25	116·83	135	230

* On the 28th, being the lowest for many months. † 0·80 inches in one day alone, viz., the 11th October.

1826.

Month.	Thermometer. In Kingstown. Lowest at Sunrise.	Thermometer. In Kingstown. Highest at 2 P.M.	Thermometer. In Kingstown. Monthly mean.	Rain, in inches. In Kingstown. 1825.	Rain, in inches. In Kingstown. 1826.
January	76	87	81·70	3·18	6·06
February	74	84	78·90	2·16	7·26
March	70½	82	77·52	3·87½	4·01½
April	76	85½	80·08	2·80	1·51
May	77	87	82·02	5·63	3·08
June	77	86	81·78	10·13½	10·81
July	79	86½	81·86	5·35	7·54
August	77½	87	82·37	5·81	8·35
September	76½	88½	82·81	9·61½	8·96
October	78	87	82·56	8·67	7·33½
November	76	88	82·10	11·82	6·47½
December	76½	87	81·55	9·90	5·13
Year	76·17	86·29	81·27	78·94½	76·52½

* Lowest observation for some years.—Wind N.

1827.

Month.	Thermometer. In Kingstown. Lowest at Sunrise.	Thermometer. In Kingstown. Highest at 2 P.M.	Thermometer. In Kingstown. Monthly Mean.	Thermometer. In Kingstown. Mean, 1826.	Pluviameter. Quantity of Rain, in inches. In Kingstown. 1826.	Pluviameter. Quantity of Rain, in inches. In Kingstown. 1827.	Pluviameter. Quantity of Rain, in inches. In Charaib country. 1826.	Pluviameter. Quantity of Rain, in inches. In Charaib country. 1827.
January	73	86	80·21	81·70	6·06	4·11	7·84	4·42
February	75	85	79·56	78·90	7·26	3·70	6·14	3·93
March	75	86	80·35	77·52	4·01½	4·51	5·44	4·81
April	77	87	81·49	80·08	1·51	1·39½	2·09	2·41
May	78	86½	82·10	82·02	3·08	2·88	3·58	5·65
June	78	87	82·30	81·78	10·81	10·61	8·96	13·46
July	78	86½	82·05	81·86	7·54	15·89	7·26	12·08
August	77	87	81·93	82·37	8·35	14·14	7·55	15·50
September	78	88½	83·02	82·81	8·96	5·71	7·61	7·35
October	78	88	82·02	82·56	7·33½	11·20	13·49	21·96
November	78	87½	82·45	82·10	6·47½	8·36	6·82	9·48
December	74	86	80·56	81·55	5·13	5·91	9·24	9·57
Year	76·58	86·75	81·50	81·27	76·52½	88·41½	86·02	108·62

The mean state of the Thermometer, at an elevation in the mountains, during the month of October, was 73·58 ; and the lowest observation taken there on any one day 65°, at sunrise on the 17th December; the highest at sunset, 77.

1828.

Month.	Thermometer. In Kingstown. Lowest.	Thermometer. In Kingstown. Highest.	Thermometer. In Kingstown. Monthly mean.	Thermometer. Mean, 1827.	Pluviameter. Quantity of Rain, in inches. In Kingstown. 1827.	Pluviameter. In Kingstown. 1828.	Pluviameter. Charaib country. 1827.	Pluviameter. Charaib country. 1828.	Hygrometer. Kingstown. 1828.
January	74	84	79·09	80·21	4·11	4·18	4·42	2·10	...
February	74	84	78·49	79·56	3·70	3·23	3·93	4·50	...
March	71½	84½	79·41	80·35	4·51	1·38	4·81	2·61	42·88*
April	75	86½	80·63	81·49	1·39	4·08	2·41	5·82	42·00
May	76	87	82·34	82·10	2·88	4·67	5·65	7·85	44·41
June	77½	87	82·[illegible]2	82·30	10·61	9·55	13·46	14·70	45·50
July	76½	88	82 12	82·05	15·89	7·97	12·08	6·62	44·79
August	77½	89½	83·60	81·39	14·14	6·96	15·50	6·74	44·76
September	78	89½	83·45	83·02	5·71	12·02	7·35	16·58	44·48
October	79	89	83·28	82·02	11·20	10·24	21·96	10·50	43·85
November	76	89	82·79	82·45	8·36	7·88	9·48	5·49	43·62
December	73	86	80·13	80·50	5·91	5·54	7·57	9 26	43·53
Year	75·66	87·00	81·48	81·50	188·41	77·70	108·62	92·77	43·68

* The lowest denotes dry, the highest moist weather.

1829.

Month.	Thermometer. In Kingstown. Lowest.	Thermometer. In Kingstown. Highest	Thermometer. In Kingstown. Monthly mean.	Thermometer. In Kingstown. Mean 1828.	Pluviameter. Quantity of Rain, in inches. In Kingstown. 1828.	Pluviameter. Quantity of Rain, in inches. In Kingstown. 1829.	Pluviameter. Quantity of Rain, in inches. Charaib Country. 1828.	Pluviameter. Quantity of Rain, in inches. Charaib Country. 1829.	Hygrometer. Average thereof in Kingstown. 1828.	Hygrometer. Average thereof in Kingstown. 1829.
January	71½	85	79·27	79·09	4·18	3·16	2·10	6·10	....	42·64
February	74½	84½	79·42	78·49	3·23	2·63	4·50	4·40	....	41·54
March	73½	87	80·32	79·41	1·38	1·18	2·61	1·10	42·88	40·91
April	77	86½	81·28	80·63	4·08	1·43	5·82	0·92	42·00	40·96
May	78	87	82·63	82·34	4·67	4·89	7·85	2·55	44·41	42·36
June	78	87	81·86	82·42	9·55	9·75	14·70	8·46	45·50	44·24
July	78	87	82·12	82·12	7·97	7·97	6·62	9·74	44·79	44·55
August	78½	88	82·71	83·60	6·96	8·05	6·74	8·08	44·76	44·90
September	77	90	83·66	83·45	12·02	3·40	16·58	5·52	44·48	44·12
October	78	90	83·26	83·28	10·24	8·15	10·50	6·16	43·85	44·12
November	77	88	81·93	82·79	7·88	7·03	5·49	7·69	43·62	44·16
December	75	87	80·03	80·13	5·54	7·51	9·26	7·56	43·53	44·32
Year	76·33	87·25	81·54	81·48	77·70	65·15	92·77	68·28	43·98	43·34

ABSTRACT of Monthly Means at Kingstown, St. Vincent's.

Year.	Temperature.	Rain in inches.
1823	81·10	68·990
1824	81·10	85·500
1825	82·21	78·945
1826	81·27	76·526
1827	81·50	88·415
1828	81·48	77·700
1829	81·54	65·150
Mean of seven years	81·45	77·31

N.B.—The above tables, which have been carefully copied from the originals, seem to contain some discrepancies; but as the variations between the given means and some of them, as deducible from calculation of the given figures, do not appear to differ very considerably, and as no check can now be put on them, and they can only be taken as approximations, they may yet serve to give a general idea of the climate, and as such they are here recorded.

No. 5 (*p.* 21).—*Wallaroo, S. Australia.*

"This is the barest, driest spot conceivable; since Valparaiso I have seen nothing so dry. There was once scrub and grass; now there is a relic of each, and much dust. All the timber having been taken off for fuel, for miles and miles, all is red-hot and dusty."—Commodore Goodenough's Journal, p. 263, Jan. 27, 1875.

No. 6 (*p.* 35.)—*Value of Forests.*

Mr. Ellwood Cooper, after pointing out how great climatic changes have taken place within the period of human history, in many eastern countries, once highly cultivated and densely peopled, but now arid wastes, and this "by the improvident acts of man in destroying the trees and plants which once clothed the surface and sheltered it from the sun and the winds"—goes on to point out that "in European countries, especially in Italy, Germany, Austria, and France, where the injuries resulting from the cutting off of timber have long since been realized, the attention of the Governments has been turned to this subject by the necessities of the case, and conservative measures have in many instances, been successfully applied, so that a supply of timber has been obtained by cultivation, and other benefits resulting from this measure have been realized." * * * *

"The preservation of forests is one of the first interests of society, and consequently one of the first duties of Government. All the wants of life are closely related to their preservation; agriculture, architecture, and almost all the industries seek

therein their aliment and resources, which nothing could replace. It is from thence that commerce finds the means of transportation and exchange, and that Governments claim the elements of their protection, their safety, and even their glory.

"It is not alone from the wealth which they offer by their working, under wise regulation, that we may judge of their utility. Their existence is of itself of incalculable benefit to the countries that possess them, as well as in the protection and feeding of the springs and rivers as in their prevention against the wasting away of the soil upon mountains, and in the beneficial and healthful influence which they exert upon the atmosphere.

Large forests deaden and break the force of heavy winds that beat out the seeds and injure the growth of plants; they form reservoirs of moisture; they shelter the soil of the fields; and upon the hill-sides, where the rain-waters, checked in their descent by the thousand obstacles they present by their roots and the trunks of trees, have time to filter into the soil and only find their way by slow degrees to the rivers, they regulate, in a certain degree, the flow of the waters and the hygrometrical condition of the atmosphere, and their destruction accordingly increases the duration of droughts, and gives rise to the injuries of inundations which denude the face of the mountains.

"The destruction of forests has often become to the country where this has happened a real calamity and a speedy cause of approaching decline and ruin. Their injury and reduction below the degree of present or future wants is among the misfortunes which we should provide against, and one of those errors which nothing can excuse, and which nothing but centuries of perseverance and privation can repair."

But there is another and a more cheering era in this history. This is when civilization has advanced, and man, under the safeguard of laws, sets about reforming the desolated forest.

* * * *

We must make the people familiar with the facts and the necessities of the case. It must come to be understood that a tree or a forest planted is an investment of capital. * * The great masses of our population and land-owners should be inspired with correct ideas as to the importance of planting and preserving trees, and taught the profits that may be derived from planting waste spots with timber, where nothing else will grow to advantage."

* * * *

The author then refers to statistical returns, and says that "In 1874, there was in the New England, Middle, and Western States, an average of thirty-three per cent. of wooded land. In

France and Germany it has been estimated that at least one-fifth of the land should be planted with forest trees, in order to maintain the proper hygrometric and electric equilibrium for successful farming. Mirabeau estimated that there should be retained in France thirty-two per cent. of land in wood. In the state of Texas, it is represented that there is an area four times that of the State of Pennsylvania, without a tree or a shrub. In California there is only four-one-tenth per cent. It is to *this* State I call your attention, and to *this* people my lecture is directed. We have, perhaps, the most healthful, most equable, the best climate on this globe, and the only objections that can be urged are the prevailing high winds, and an uncertain, as well as an insufficiency of rainfall. Moderate the winds, increase the rain, and we have perfection."

* * * *

"How is this to be done? How are we to obtain this result? By planting forest trees."

* * * *

"It is known and proved that the three-fourths of the surface will produce more, if protected by trees planted on the other fourth, than the whole would without the trees and without the protection."

Here we have the opinion of a man well able to judge, and who appeals to statistics to confirm his views. What would be his opinion of a people who are found destroying some of the most valuable of the timber in any given country, without provision for the re-production of forest vegetation—sacrificing, as is the case in Australia, acres of such trees as the ironbark, white and blue gum, and other valuable ornaments of the country—and without regard to the wants of the present or future settlers, under the plea that it is advantageous to have a little more grass, and without considering others are coming after them, who have rights of which no individual is justified in depriving them.

Mr. Cooper adds to his arguments this—"What we have, therefore, to do as individuals, is to begin at once to plant. It is an obligation we owe to the possessory title to land; and financially we will be rewarded for our labours."

(*No. 7.*)—*Forest Vegetation on the Coast.*

The following extract from a letter to myself, under date of 16th November, 1876, by a friend whose powers and habits of observation are of a high order, and to whom our Society is indebted for a valuable communication on the connection of forest vegetation with geology, is worthy of consideration by those who doubt the influence of trees upon the atmosphere. "The effects of forest vegetation on climate are most marked in the Coast district, about the heads of the Macleay, Bellinger,

and Clarence Rivers, where dense scrubs containing very large trees occur. In those localities it is almost continually raining. About three years ago I made a survey of one of the heads of the Clarence River and the watershed between that river and the Macleay, and was five weeks in the scrub region. During the whole of that time, although the inhabitants there told me the weather was no wetter than usual, there were only four days in in which we were not drenched to the skin. That the weather was in its ordinary state was proved by the colour of the water in the streams, which, although copious, was not turbid, as it would have been if they had been in fresh. But in the more open country, twenty or thirty miles inland from those localities, the rainfall is not nearly one-half. This must be owing to the dense vegetation a great deal more than to the fact that the steep and high escarpment forming the edge of the table-land catches the rain-clouds: for when on the top of Point Look-out (5,100 feet high, by aneroid) the sun was shining on us, whilst we could distinctly see the rain pouring in torrents several hundred feet below, and though the place on which the rain was falling was not half-a-mile away, it was more than twenty minutes before it reached the peak. It travelled *upwards*, and it was quite as interesting to watch its approach as it was unpleasant when it arrived."

(*No.* 8.)—*Forest Protection in the Sandwich Islands.*

To complete the evidence from all parts of the globe, the following extract from the *Hawaiian Gazette* published at Honolulu, 13 Sept., 1876, is appended:—

"A Bill has passed the Assembly which at first sight may be thought to be a step in the direction of forest preservation and increase;—a measure for want of which the Islands have been suffering for many years, and will, we fear, continue to suffer as long as the present indifference on this subject continues.

"What is wanted here is a system of forest culture and conservation similar to those which various European nations have found themselves forced to adopt or forfeit their national existence. We must adopt a system whose corner-stone is the axiom, 'The greatest good to the greatest number.' If history, and experience, and science have thoroughly demonstrated any one thing in the world of material things, it is that forests are as necessary to the life of a land as lungs are to the life of the animal. When a land is shorn of its forests, its green fields become barren wastes, its rivers become dry in summer, and raging, destructive torrents in winter. Its inhabitants diminish in numbers, and it finally becomes a desert, fit only for the abode of owls and bats.

"This dismal condition is undoubtedly in store for us unless we avert it by prompt and energetic action. And no half-way measures will suffice. If we would make sure of success we must boldly inaugurate a system which will in all probability meet with strong opposition from real-estate owners;—a system which may be regarded by the few as a violation of personal rights, but which nevertheless must be enforced in the interests of the many. There should be a Forester-in-chief appointed for the whole country, whose business it shall be to supervise and direct the operations of the Bureau.

"Every man owning ten acres or more of land should be compelled to devote one-half of his land to the cultivation of trees, and all forests now existing should be maintained in vigorous health and growth, and their limits gradually increased year by year.

"Since the above was written, we notice an article on the same subject in the *Advertiser*, from the pen of Mr. Gibson, which presents some new ideas on this subject, worthy of consideration."

DISCUSSION.

Mr. CHARLES MOORE (Director of the Botanic Gardens) said they were much indebted to their Vice-President for this elaborate paper. It was a subject on which he (Mr. Moore) had thought a good deal. There were difficulties in the way of a general conclusion, so far as Australia was concerned, which he could not get over. He had been a resident in this Colony for nearly thirty years, and knew the vegetation of it better perhaps than any other living man. He had known about Wollongong what he might call a "jungle vegetation"—a vegetation with dense undergrowth, producing palms and tree ferns of enormous size. That extended from about 60 or 70 miles south to the extreme north; and was generally produced on the Coast Range. That was the kind of vegetation spoken of as inducing moisture and holding moisture.

But the whole of that vegetation had been nearly destroyed. The patch Mr. Clarke referred to at Wollongong was very beautiful. Three years ago, he (Mr. Moore) made notes of every plant there.

It was a notorious fact that the dense vegetation of this country had been almost wholly destroyed. In addition to the effects of ring-barking and other known causes, whole tracts had been destroyed without any apparent cause; perhaps from a root disease. It would follow from this, on Mr. Clarke's theory, that the climate must have become drier. But he (Mr. Moore) ventured to say the climate had not become drier. There was no apparent effect, except that where rivulets were formerly almost continually running they were dried up. The large rivers had not been affected. He spoke of Wingecarribbee. There, fourteen years ago, all the rivulets were running; a few years ago all these rivulets were dry. So with Illawarra. A few years ago nothing in the world was more beautiful than the forest vegetation and rivulets of Illawarra: now many of the rivulets were dry.

Now the main rivers of the Colony contain as much water as at any time within our knowledge. They did not find that where they destroyed forests they created deserts. They had grass; and that presented almost as great a surface to catch moisture as the trees did. With regard to stories about trees producing water, he thought they were fictitious. There was, indeed, a night-breathing or perspiration of plants. But about trees "weeping" he had much doubt. His predecessor, when lost for three weeks, between Moreton Bay and Gayndah, kept himself alive by sucking the moss of a climber. The pitcher-plant contains water, but that is distilled.

Within the last thirty years a vast extent of country has been cleared, and the climate has not been affected by it. Generally the rivers have as much water as ever. In the South of Europe they have sown the seeds of pine-trees, and the effect has been to dry up the former moisture. As for marshy places, undoubtedly the treading of cattle causes them to dry up. The lagoon at Wollongong has been thus dried up. It would be right for the Government to protect these places.

Rev. W. B. CLARKE said many of our rivers had not yet been cleared of timber. The Murray, and other rivers had never been cleared at the heads of them. But the system of ring-barking was the most serious part of the question. As to the amount of water, no data existed as to what it was thirty years ago; but floods are recorded to have exceeded those of the present time.

[The debate was then adjourned to the next monthly meeting of the Society.]

The discussion on the Rev. W. B. Clarke's paper entitled "Effects of Forest Vegetation on Climate" was resumed, 6 Dec., 1876.

Mr. C. MOORE restated the points he had previously advanced, as follows:—1. "That the dense jungle vegetation, which of all others is supposed to attract and hold moisture, and which for about 400 miles was so general within the coast range, has been almost wholly destroyed during the last thirty years. 2. That in addition to this, millions of acres of more open forest have been destroyed during the same period. 3. That, notwithstanding this tremendous destruction of trees, no drier climatic effect has been experienced. 4. So far as my knowledge extends, the only observable effect has been that in some districts in which the forest has been destroyed small rivulets usually contained water, but in many instances are now dry. 5. That now the larger rivers of the Colony show no diminution in breadth or depth. 6. That the rainfall, instead of decreasing, as might have been expected from the destruction of so much forest, has been of late years more regular and greater than formerly.'

Mr. W. A. BRODRIBB complimented the writer of the paper on his able performance, and agreed with him on the main points he brought forward. It was most necessary that our useful timber should be preserved by legislation. The red gum was being destroyed on the rivers. Then there was the pine, in the Riverine country, valuable for buildings and fences, that should be preserved; and there were the stringybark, the cedar, and various other timbers that should be protected. He considered though that our scientific gentlemen made a mistake in drawing comparisons between the forests in the southern and northern hemispheres. The forests in the northern hemisphere shed their leaves to the depth of twelve or eighteen inches, which formed a

manure that supported the trees in spring. In the southern hemisphere the forests took everything out of the ground and gave nothing to it. He was not opposed to barking the trees to get rid of those that were useless. Much of the forests of Australia was totally useless. What a wretched forest there was on the road to Bowenfels—perfectly useless to man and beast. If it could be removed and English trees planted, there would be a far different state of things in the locality, as the timber which absorbed the moisture that fell from the heavens would be away.

Dr. NEILD read from a report by Mr. Fryar, an owner of estates in Antigua, upon the effects of forest destruction in the island of Mauritius. The effect of the destruction of forests in a tropical island like Mauritius would be followed, the writer stated, by a decrease of humidity, an elevation of temperature, and a diminution in the rainfall.

Mr. DIXON stated his experience after a residence of seventeen months on Maldon Island, in the Pacific. No rain fell on the island during that time, though rain could be seen falling to the north and to the south; and as soon as clouds came over the island they disappeared. At one time the island was inhabited, and must have had forests upon it; but while he was there only two or three small patches of trees existed, and it was evident that the scarcity of timber caused a want of rain.

The Rev. W. SCOTT explained that clouds over-saturated with moisture passing over a dry island like the one mentioned would be no longer over-saturated when they met with the heated air rising from the island, and therefore no rain would fall; but when the clouds passed beyond the island they might meet with a cooler current of air, and, again becoming over-saturated, rain would fall.

The CHAIRMAN replied to the points advanced by Mr. Moore, and challenged him to produce data in support of his 5th and 6th propositions now brought before the meeting. He referred to the letters from Mr. De Salis which appeared in the *Herald*, and, proceeding, said:—I cannot see that in characterising ring-barking as it has been practised in these Colonies as I did, and do, I have anything to retract. Mr. De Salis admits in his second letter "that ring-barking worthless scrub is the legitimate use of ring-barking, but to ring-bark a forest of well-grown or well-growing trees is its abuse." If this were all that I intended, we might have, doubtless, been spared the necessity of alluding to the practice at all. I maintain, however, that "well-grown and well-growing trees" that are not "useless scrub," have been ring-barked in various parts of the country to a great extent—and that some of the most useful and valuable timber trees have been ruthlessly killed, and it was to this wanton use of the axe

I objected, and do still object. About ten days ago, I asked a fencer of great experience, who was then putting up a fence more than a hundred miles from Sydney, whether he had ever known "ironbark trees to be ring-barked," and his reply was, "hundreds of acres of that and other valuable timber." And I know from other sources to which I have applied for information, in the desire to find out if I had in any way misstated the fact, that such timber is still being ring-barked. My first objection to ring-barking is, that it is a practice of a slovenly and a greedy kind, and is adopted to save the expense of clearing and stumping the ground. It is what, to use the language once heard in the British Parliament, is merely a "breeches pocket" policy, though some think it is of national advantage to keep a few pounds in, or to add a few pounds to the purse of an individual, without reference to future conditions or the claims of posterity, and this is the only argument yet advanced to us to justify the practice. I give these gentlemen full credit for their patriotic determination to do what they can for the good of their adopted country, and I hope we are all, even the un-acred members of this Society, aiming in our respective occupations at the same end. Nor have I denied that if a dead tree does allow more grass to grow than a living one, some advantage for a time may be gained; but when the dead tree decays and scatters its branches over more ground than it covered before, would that be an advantage or a disadvantage? And must not that eventually be the case, and so injury be done to the future occupant, or free selector who is now, by law, entitled to all the advantages of occupancy? It is very well to talk of "worthless scrub on dry ranges"; but what is to be said respecting full, well-grown, useful timber on plains or gently undulating ground? I am challenged to "figures," which are to convert "theory into science." Now, as I have before said, the figures are only to be found in the possession of those who profit by them, and so the science of the question cannot be submitted as a sum in addition or subtraction; it must therefore rest on other experiences, and as yet we have no data to appeal to beyond the experience of persons in all other parts of the world, and to those I have already appealed. There are no published data in this Colony as to the advantages even alleged to have been gained by ring-barking of worthless "scrub on dry ranges." Figures founded on unknown data or on imperfect premises may prove anything or nothing, and have not even the value of the theory which is said to be founded on "five columns" of what has been called "inconclusive quotations." I repeat, let "all the figures be imported, as well as the momentary profits" of ring-barking. This is for the assertor of those profits to do. And till this has been done the figures have only a one-sided value. But the other

side of the ledger must be filled in (till the data have been produced) by experiences—and in such case the experience of the whole world, I may say, is no mean representative. This, therefore, represents what I have to say against the injudicious destruction of forest vegetation. And if it be not enough to satisfy commercial interests, it ought at least to satisfy common sense and unbiased judgment. "The facetiæ as to creating water" are founded on what I would not like to call ignorance of physics, but certainly on a want of recollection. What is rain—what is snow—what is hail—what is fog—what, dew? All are but various forms of precipitated or condensed vapour; nor can that vapour become or be created rain till the vapour has been subjected to some process, visible or invisible, by which the atmosphere which holds the vapour has by some agency been forced to part with it. If forests act as an agency of the kind, he who plants trees or preserves trees, capable of performing any portion of this agency, is a creator of water; and however ridiculous it it may seem to a sceptical opponent, reason will teach us that if the statements I have quoted are reliable, "forest vegetation" is an agency in "creating water." I have quoted the case of Ascension Island in the midst of the Atlantic Ocean, as well as other oceanic islands, in order to show how, even in the midst of the ocean itself, rain ceased when vegetation was destroyed, or passed suspended as vapour over the speck of land, and that it again resumed its fall when re-plantation had taken place, and singularly enough some of the chief plants introduced to effect this return to former deposition of moisture were our Australian wattles. In this instance, at least, trees were condensers of vapour on a mere speck of land surrounded by the ocean waters, which refused to contribute to a naked surface. Similar instances occur even on the edge of or within a desert, and the report of Vice-Consul Dupuis to the British Government on the condition of the desert country in the neighbourhood of Tunis may be referred to in confirmation. We are told what Elihu Burritt says of the loss of £8,000 by allowing one hedge oak tree to stand (when perhaps according to some, it ought to have been ring-barked or better cut down). But does any one in his senses believe that that tree did not spread moisture around it, keep vegetation greener in the vicinity, suck up nutriment, or supply it to deep strata, and shed its leaves to nourish the soil? It may have been three centuries before the farmer took up his land, and if he preferred the handful of grass that could grow where it stood, he might, in all probability, have found space enough elsewhere in some unoccupied patch of ground on his farm for a similar quantity. If an oak by its roots carries down moisture to deep cracks in the underlying strata, and so adds to springs; or, if even a gum-tree, whose roots run along just below the surface, do

the same to a less extent, they, each in its own way, contribute to the general growth of other kinds of vegetation; and we have instances enough in Australia of the effects of even an ordinary drought on pastures to bid us be cautious how we rashly cut away all chance of nourishment so produced from the roots of grasses themselves. We all know how long it takes to revive pastures that have once been scorched into a state near to destruction. I am given to understand that Mr. Brodribb himself, and his relation Mr. Desailly, in Victoria, had sad experience of it. Can we believe that the dead roots of trees are more available for such a process than living roots, or that the whole order of nature does not show that it was the will of the Creator that the earth should be replenished by arboriculture and agriculture as well as by the culture of grasses, seeing that trees and grasses all came in together in the same natural epoch, and have ever since thriven together in harmonious union? To suppose a continuance of this does not imply the neglect of judicious clearing of land—ring-barking does not clear it—and some land must be cleared, if the hoped for influx of population should take place. But, unless men be contented to live without the shelter and other benefits of trees, and will not provide them where needed by fresh plantations, they can only inhabit, like the nomadic races, a half-desert region, where there may be only dry river beds and wells that hold no water. I would ask those who are doubtful, to carefully peruse the documents from which I have quoted in my original paper, and to weigh well the words of a writer in a late number of *Chambers's Journal*:—"Whilst extensive forest clearings have been made, reckless of consequences, in India, the United States, and other portions of the globe, France was the first country to awake to the folly of the system. The old seigneurs loved woods; the peasant farmer hates them. In the south, where the land has been more cut up into small properties than in other parts, the trees have been so cleared off that there are whole communes without any—mountain communes, which, owing to the now unchecked action of the rains, bid fair to be nothing but bare rock. The peasant grubs up a tree, and thereby gets a few more square yards for his rye or lucerne; but also he helps to keep off the gentle rains, and to bring about destructive droughts, alternately with no less destructive floods. That, at any rate, was the conclusion to which years of study and observation led M. Becquerel, who, a quarter of a century ago, published his book on the Effects of Forests on Climate." (30th September, 1876, p. 591.) I may add that I very much regret never having seen M. Becquerel's work, as I doubt not I could have found in it many corroborations, as strong as that last quoted, of the justness of the views which I have now endeavoured to enforce and illustrate. Lastly, to meet an argument which I have heard in favour of ring-barking and clearing

on account of the saving of moisture for the lesser vegetation, I will venture, in a final brief extract, to refute it in the words of the same writer in *Chambers's Journal*, just referred to. "Of course, since rain comes, because the air is too cool to hold its moisture any longer in solution, there ought to be more rain in a wooded than in a treeless district; and so there is, from 6 to 8 per cent., as M. Faudrat found by putting up several rain-gauges, some in a forest seven yards above the tree-tops, others on treeless ground, some two hundred yards off. . . . It may be said if the trees bring more rain, they use up more than the treeless ground, for their roots drain the soil, and their leaves drain the atmosphere. Not so; though wood is more than half water, the amount of water contained in all the wood in a forest is the veriest trifle compared with the rain that falls on it during a year. Moreover, a series of experiments seems to show that the amount of water decomposed by an acre of forest is very much less than that required by an acre of cabbage, or wheat, or clover. Again, because pines and other trees (notably the blue gum, *Eucalyptus globulus*, which is being planted by the million in Algeria) dry up marshes, it has been argued that trees must lessen the water supply. But here again experiment comes in and proves that this drying up is not due to evaporation through the leaves or to the water being in any other way sucked up by the trees. All the trees that have this property can and do thrive also in hungry soils; they drain the soil by virtue of their spreading roots, which enable the water to run into the lower strata, and this meets the observation of my friend Mr. Brodribb (whom I am glad to meet here to-night after twenty-five years' acquaintance, as a member of our Society), that the trees on the road to Bowenfells are perfectly useless to man and beast—for they are not perfectly useless in another way, as they supply water to the deep creeks which are the feeders of the Nepean and Hawkesbury. If any further argument is required, it may be well to refer to the experiments carried on in France during the last twelve years, and to leave opponents to be refuted as the Directors and Inspectors of Forests refuted the misunderstandings of Louis Napoleon and M. Fould.

But if gum-trees, as well as others, produce accession of water to the earth below, is it not suicidal to ring-bark trees, destroying the capacity to do what nature demands? If trees are to do what experiment suggests, and what ring-barking indiscriminately carried on altogether prevents, will it not hereafter be found to be folly, when too late, whatever the temporary profits be at the moment? Lastly, I would ask why in the neighbourhood of ring-barked areas the natural forestry loses its vigour, and appears to suffer from a want of nourishment?

FOSSILIFEROUS SILICEOUS DEPOSIT FROM THE RICHMOND RIVER, N.S.W.

By Archibald Liversidge, Professor of Geology and Mineralogy in the University of Sydney.

[*Read before the Royal Society of N.S.W.*, 6 *December*, 1876.]

Most of the specimens of this material which I have had the opportunity to examine, exhibit many of the appearances which are usually presented by the deposits thrown down from hot springs or geysers.

Although no such hot springs or geysers are known to exist at the present day in the Colony, yet I understand from Mr. W. Wilson, of Monaltrie, to whom I am indebted for my specimens, that the district in which they occur presents many features which lead him to consider that it has been the scene of comparatively recent (*i.e.* in a geological sense) active volcanic phenomena.

The district has not, I believe, been examined in detail by any trained and experienced geologist; but judging from Mr. Wilson's account it must be one of remarkable interest.

Basaltic and trachytic rocks are the principal surface rocks occurring in the neighbourhood. The basalt is remarkable for containing very large and well developed amygdaloids of chalcedony, agate, arragonite, and certain of the commoner zeolites. Of the amygdaloidal and other minerals, together with specimens of the matrices, Mr. Wilson sent a large series to the Commissioners for the Philadelphia Centennial Exhibition—the collection of which must have entailed the expenditure of much time and labour.

In the interior of the mass, the siliceous deposit is usually of a more or less pale wax colour, and in certain respects closely resembles *wood opal*. Wood opal is actually present, and in parts streaks of true opal, although not of the precious variety, occur. Occasionally, on breaking open a specimen, jet-black patches are met with; the colouring matter apparently contains carbon, as it is slowly burnt off in the blow-pipe flame.

On the surface, the mineral weathers white, and the decomposition passes in to a depth of from ¼ to ½ inch.

Chemical Analysis.

Weathered portion.

Moisture, given off at 100°	4·16
Combined water (loss on ignition) ...	1·78
Insoluble silica...	89·74
Soluble silica	·47
Alumina and iron sesquioxide ...	1·18
Lime	·48
Magnesia	1·98
Loss	·26
	100·00

Specific gravity, 2·046 at 66° Fah.
Adheres strongly to the tongue.

Unweathered portion.

Water, given off at 100°	4·08
Combined water (loss on ignition) ...	·48
Insoluble silica...	91·67
Soluble silica	·30
Alumina and iron sesquioxide ...	1·56
Lime	·36
Magnesia	·55
Loss	·90
	100·00

Specific gravity, 2·330 at 66° Fah.

The composition shows that it answers to the common siliceous sinters or geyser deposits.

It will be seen that the weathered specimen has a lower specific gravity, and contains rather more water, also more lime and magnesia.

In places the structure is more or less distinctly lamellar, evidently due to the manner of its deposition is successive layers. The fracture is more or less distinctly conchoidal across the planes of deposition, but where the lamellar structure is less strongly marked or altogether obliterated, the fracture is conchoidal in all directions.

The weathered surface is usually marked with the remains of ferns, which stand well out in relief; with the ferns and stems are the fruits and seeds of other forms of vegetable life.

Within the substance of the mass occasional layers of a brilliant white colour are met with, and along these layers it splits into flakes and slabs with more or less ease; these white

LIVERSIDGEA

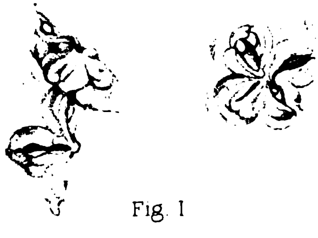

Fig. I

Fig. VI

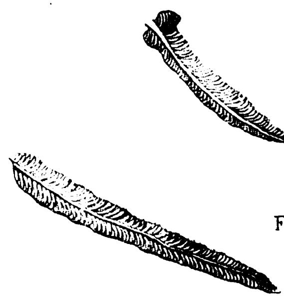

Fig VII

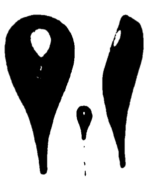

Fig V

Fig II

Fig. III

Fig VIII.

Fig IV

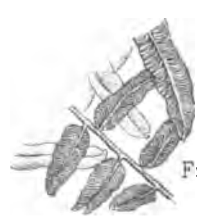

Fig. IX

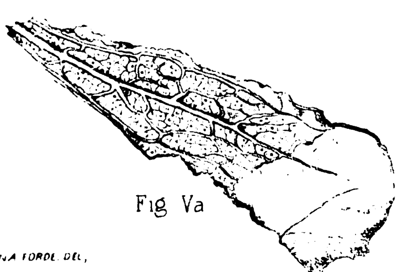

Fig Va

S T LEIGH & Co LITH.

HELENA FORDE DEL,

LIVERSIDGEA OXYSPORA

I Fruit Nat size
II & V Seed Magnified 5 times
III. Seed Nat size
IV Leaf „ „
Va Leaf Magn. 5 times

layers are much softer than the other portions, and they are found to be composed almost exclusively of the casts of vegetable tissue; the fern fronds and stems are especially well preserved. Also scattered irregularly through these layers and the solid substance of the mineral, the remains of certain fruits and seeds are met with.

These latter were submitted to the Baron von Müller, C.M.G., M.D., F.R.S., the highest authority upon Australian Botany, who at once pronounced them to belong to a new genus; I now beg to append his description, and at the same time to tender to him my best thanks for his ever ready assistance in all questions relating to botanical matters:

Description of Fossil Fruits in Siliceous Deposit, Richmond River. By the Baron Von Müller, M.D., C.M.G., F.R.S.

LIVERSIDGEA.

Fruit divided into four (or perhaps more) turgid lobes; each division outward free and dorsally rounded, the cells filled with a plicate substance.

Placentas parietal. Seeds several (or perhaps many) imbedded in the folds of the inner substance, turgid-oval towards the one extremity, thence gradually attenuated to the almost pungent point of attachment. Testa thin and pale; nucleus very smooth and shining; chalaza somewhat lateral, close to the turgid extremity of the seed, rather large, orbicular-oval.

Liversidgea oxyspora.

Diameter of fruit ⅔ to nearly 1 inch. Seeds from 2 to 3 lines long, the inner portion homogeneous from infiltration of silicic acid, with no trace of original cotyledonar division, hence the embryo probably minute, within a copious and equable albumen.

In tracing the affinity of this vegetable relic, we are reminded as well of the aurantiaceous tribe of *Rutaceæ* as of *Guttiferæ*, from both of which the exterior placentation would already separate it, while by this the alliance to *Capparideæ* and *Bixaceæ* is indicated, but from the material hitherto obtained the precise ordinal position of this new generic type dedicated to the learned discoverer cannot yet be affirmed.

The form of the seed is remarkable, and gave rise to the specific name.

There is one impression of a leaf with these fruits, and this leaf probably belongs to the plant the fruits of which are now described.

See plate, figures I to V. Figures VI to IX represent the ferns accompanying the fossil fruits.

The so-called Meerschaum from the Richmond River, N.S.W.

I take this opportunity to mention also that there is a deposit of very white and porous hydrous silicate of alumina on this river, which has often been sent down to Sydney as meerschaum. Probably this is partly due to its low specific gravity, for when first immersed it floats upon water. It is sometimes said to contain leaf impressions; colour, dead white; breaks with more or less well-marked conchoidal fracture; shows traces of stratification; very porous, and adheres strongly to the tongue; H = about 2; can be scratched by the thumb-nail, and leaves a mark on cloth, but not readily.

Sp. gr. after immersion in water for some time = 1·168. Before the blowpipe blackens slightly at first, and becomes harder after ignition; it is infusible, and yields a blue mass when ignited after moistening with cobalt nitrate; this at once distinguishes it from meerschaum, which would under those circumstances afford a pale pink-coloured mass.

Analysis.

Water, given off at 100°	8·28
Combined water (loss on ignition)	4·34
Insoluble silica	51·35
Soluble silica	·11
Alumina	37·72
Iron sesquioxide	·46
Lime	·34
Magnesia	1·25
Alkalies	traces
Carbonic acid	1·54
	100·39

The low specific gravity is a most remarkable characteristic of this mineral, but in other respects it answers to *cimolite*, the *κιμωλια* of Theophrastus.

[Plate.]

ON A REMARKABLE EXAMPLE OF CONTORTED SLATE.

By Archibald Liversidge, Professor of Geology and Mineralogy in the University of Sydney.

[*Read before the Royal Society of N.S.W.*, 6 *December*, 1876.]

The specimen of more or less imperfect slate which I now have the pleasure to lay before the Society is, I think, a most remarkable example of true contortion, accompanied by slaty cleavage, but contortion on such an extremely small scale that it in certain aspects appears to resemble the well-known cone-in-cone structure seen in coal and many rocks.

The specimen was obtained by Mr. Fielder from the Peelwood Copper Mine, near Tuena. Mr. Fielder succeeded in detaching this most interesting and beautiful example from a projecting point of weathered rock, but only after the expenditure of much time and trouble, for the slaty rock was far too tough, and also too fissile, to admit of its being broken off in large blocks by blows from a hammer or pick, so he had to saw it off—a very tedious and laborious operation.

It will be equally observable in the specimen and the photographs which I lay before you, that some of the plications are not more than, even if so much as, an eighth of an inch across, whilst the widest of them do not exceed two inches, and the depth of the largest cleavage plane in the specimen barely reaches three inches; its extent in the direction of from before backward I have no means of telling, as the specimen sawn off had a thickness of but about two inches. The dark lines *l*, *m*, *n*, and *u*, *v*, in plate II, represent fractures in the specimen, and their plications beautifully indicate the cleavage planes to which they are parallel. Whether the cleavage planes extend over any length of country I do not know, as I have not visited the locality whence the block was brought, neither have I been able to obtain particulars on this point. The contortion is probably of quite a local character, as it does not appear to have been noticed elsewhere in the district.

The rock or slate has the appearance of the grey killas of Devon and Cornwall; it is in all probability of Devonian age.

As I have before mentioned, the specimen has somewhat the appearance of the familiar cone-in-cone structure (see figures, two-thirds of natural size—No. I shows the weathered surface, and No. II a smooth and imperfectly polished one). The surface, which has been carefully rubbed down and smoothed, presents a series of alternating light and dark bands, similar to the banded or ribboned appearance exhibited by a well-kept English lawn cut by a mowing machine which has been worked in lines alternately up and down the length of the lawn.

This banded effect is due to the manner in which the light is reflected from the cut edge of the cleavage planes. When held in one position the smooth surface presents a fairly uniform grey tint, but at a certain angle to the light it appears to be made up of alternate light and dark bands, and when reversed in position the light bands become the dark ones and *vice versâ*. Thus, in one position the bands *a, b, c, d, e, f, g, h, i, j*, appear light grey, but when the specimen is turned upside down they exhibit a dark grey shade.

Even if subsequent examination made on the spot should prove this to be a case of cone-in-cone structure, the specimen will still, I think, be of equal value and interest.

The chemical composition of the slate is as follows:—

Analysis.

Hygroscopic moisture	00·48		3·85
Combined water (by difference)	3·37		
Silica	·22	Soluble in acid	10·51
Alumina	3·63		
Ferric oxide	4·47		
Lime	·19		
Magnesia	traces		
Soda	1·16		
Potash	·84		
Silica	67·64	Insoluble in acid	85·64
Alumina	16·77		
Ferric oxide	1·23		
			100·00

Sp. gr. = 2·75, given by small fragments which had been immersed in water for some time, at 75° F.

[Two plates.]

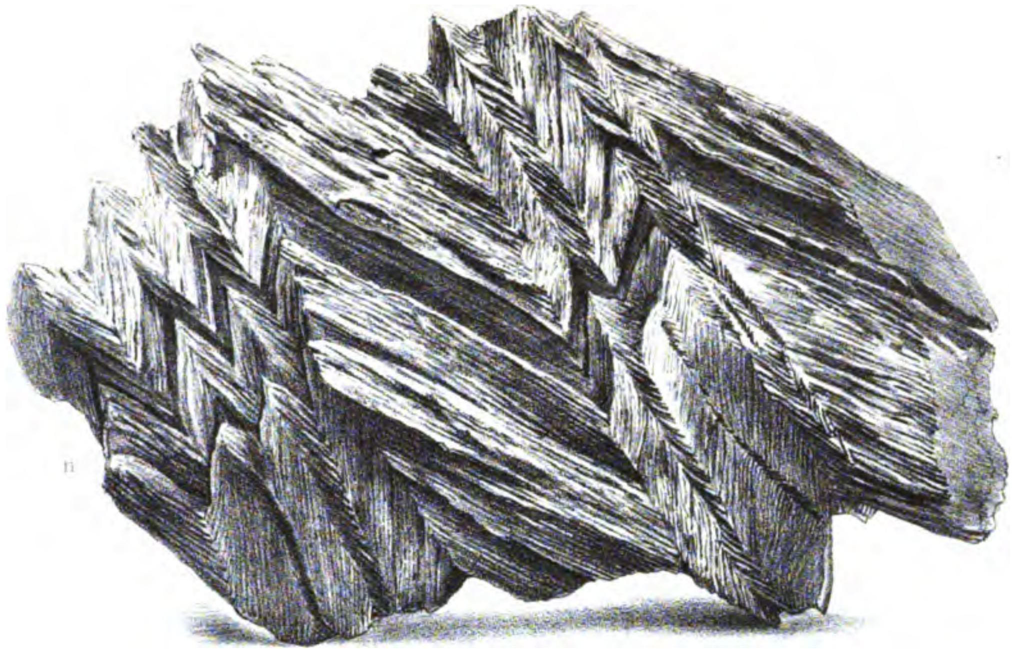

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Fig. I.
CONTORTED SLATE (Peelwood, N.S.W.)
Weathered Surface.

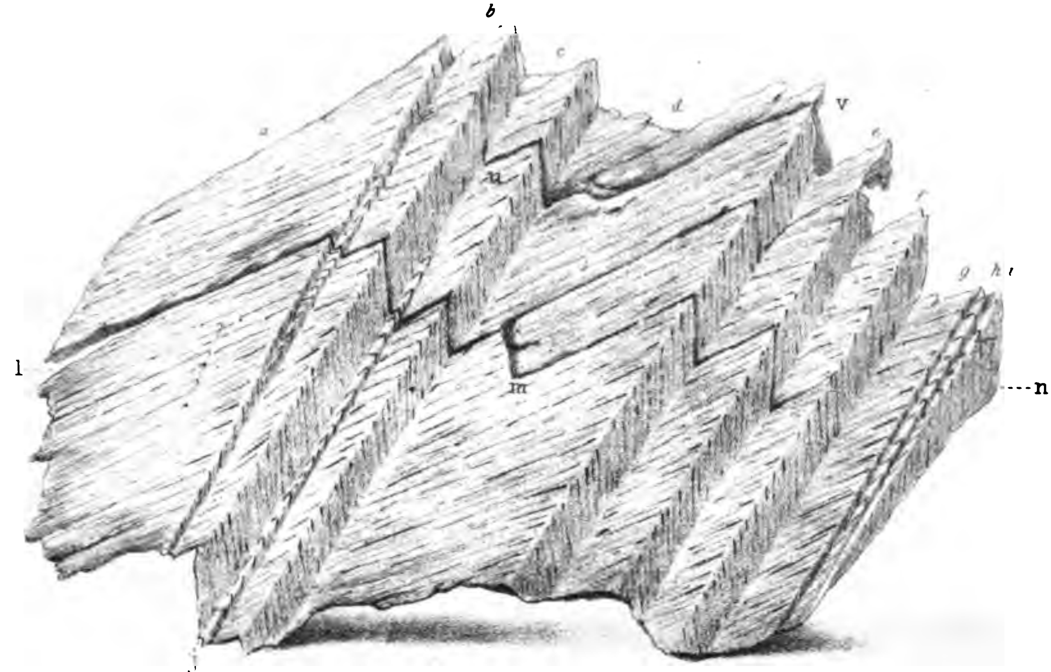

Fig. II.
CONTORTED SLATE (Peelwood, N.S.W.)
Polished Surface.
⅔ Nat Size

S.T. Leigh & Co. lith. Sydney

PROCEEDINGS.

PROCEEDINGS

OF THE

ROYAL SOCIETY OF NEW SOUTH WALES.

WEDNESDAY, 3RD MAY, 1876.

The annual *conversazione* was held in the Masonic Hall; many interesting and valuable examples of optical, electrical, and pneumatic apparatus; geological and other collections; maps, photographs, rare prints, books, and other objects were exhibited by various members of the Society.

The exhibits, many of which were microscopes, bordered close upon one hundred in number.

Including the members and their friends, the number of guests amounted to nearly four hundred.

WEDNESDAY, 17TH MAY, 1876.

Ordinary monthly meeting of the Royal Society of New South Wales, held in the Society's Rooms, Elizabeth-street.

The Rev. W. B. CLARKE, V.P., in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society:—

Francis Henry Wilson, Union Club.
John Usher Cox Colyer, A.S.N. Co., Sydney.
Percy Williams.
Cecil West Darley, Newcastle.
Arthur Dight, Richmond.

Seventeen new candidates were proposed and seconded.

The meeting then balloted for the officers for the ensuing year, and the following gentlemen were duly elected, viz.:—

PRESIDENT
(ex officio):

HIS EXCELLENCY SIR HERCULES ROBINSON, K.C.M.G., &c., &c., &c.

VICE-PRESIDENTS:
REV. W. B. CLARKE, M.A., F.R.S., F.G.S.
H. C. RUSSELL, B.A., F.R.A.S.

HONORARY TREASURER:
REV. W. SCOTT, M.A.

HONORARY SECRETARIES:
PROFESSOR LIVERSIDGE. DR. ADOLPH LEIBIUS.

COUNCIL:

LORD, THE HON. F., M.L.C.	ROLLESTON, CHRISTOPHER.
MANNING, JAMES.	SMITH, THE HON. J., M.D., LL.D.
MOORE, CHARLES, F.L.S.	WRIGHT, H. G. A., M.R.C.S.

The Honorary Treasurer read the following Financial Statement for the year ending 30th April, 1876:—

RECEIPTS.

To Balance in the Union Bank on the 30th April, 1875	£ 90	0	0
„ Subscriptions and Entrance Fees	222	11	0
	£312	11	0

DISBURSEMENTS.

By Rent of Rooms from 1st May to 31st January, 1876	£ 37	10	0
„ Office Keeper (Mrs. Casey)	8	0	0
„ Office furniture and effects	64	16	6
„ Refreshments for monthly meetings	10	16	7
„ Stationery and Printing Account	27	1	0
„ Advertisements	8	8	6
„ Postage and Petty Cash Account	17	2	1
„ Assistant Secretary's salary from 1st Jan. to 31st Dec., 1875	40	0	0
„ Balance in the Union Bank on 30th April, 1876	98	16	4
	£312	11	0

ASSETS.

To Balance in the Union Bank	£ 98	16	11
„ Furniture, books, and pictures	150	0	0
„ Subscriptions due	13	13	0
	£262	9	4

LIABILITIES.

By Rent of Rooms to 30th April	£	12	10	0
„ Periodicals ordered		30	0	0
„ Assistant Secretary's salary from 1st January to 30th April...		13	6	8
„ H. W. Ingram (Collector)—Commission		4	19	9
„ Office Keeper		2	6	6
„ Balance of Assets over Liabilities		199	6	5
		£262	9	4

The Treasurer remarked that the expenditure had been larger last year than usual, in consequence of the Society having had to provide the necessary furniture for the rooms.

Mr. Wm. Neill moved the adoption of the Balance Sheet, and congratulated the members on the present very satisfactory position of the Society.

Mr. John Alger seconded the motion, and in so doing asked whether the books and picture belonging to the Society were insured.

The motion having been put from the Chair was carried, and the question of insurance was referred to the Council.

The Chairman announced that fifty donations had been received during the recess.

The Anniversary Address by the Revd. W. B. Clarke, F.R.S., Vice-President, was then read by the Revd. Wm. Scott, at the request of the Revd. W. B. Clarke.

Mr. Alfred Roberts asked what order it was proposed to take in the formation of the Sections suggested in the Address.

Professor Liversidge said, that at the next Council meeting a definite scheme would be drawn up—some suggestions might now be thrown out.

Mr. Alfred Roberts suggested that the Chairman of each Section should be *ex officio* a Member of the Council of the Society.

Copies of correspondence with respect to the exchange of scientific publications was laid before the members, viz. :—

In June last the Hon. Secretaries forwarded copies of the following circular to the Foreign Consuls resident in Sydney, accompanied by a request that they would exercise their interest to bring the same before the notice of the various Scientific Societies in their respective Countries :—

[CIRCULAR.]

THE ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's Rooms, Sydney, 25 June, 1875.

The Royal Society of New South Wales desires to enter into correspondence with similar Scientific Societies and Institutions in other Countries, for the purpose of making a friendly interchange of information and publications. The annual Transactions published by the Society consist of original scientific articles, which usually relate to the Geography, Geology, Mineralogy, Natural History, Meteorology and General Resources of the Colony of New South Wales. Communications may be addressed to one of the Hon. Secretaries.

In addition to the above, there was appended a list of the Officers for the current year, and a copy of the Fundamental Rules of the Society.

To this circular favourable replies were returned, with cordial offers of co-operation.

Since the distribution of the circulars, the following communications have been received:—

Copy of letter received by the American Consul.

THE SMITHSONIAN INSTITUTION.

Washington, 20 November, 1875.

J. H. WILLIAMS, Esq., U.S. Commercial Agent, Sydney, N.S.W.

Dear Sir,—Your letter of September 11th, with the accompanying circulars from the Royal Society of New South Wales, was duly received; and after having endorsed the circulars in a note calling special attention to them, and an offer to be the medium of exchange between their recipients and the Royal Society, we duly distributed them to some of the principal Institutions of this Country. This Institution has charge of the National Museum, and is desirous of enriching it with specimens of Ethnology and Natural History from New South Wales. Anything, therefore, belonging to those branches of Science would be thankfully received, and the favour reciprocated by specimens from this Country.

I remain, etc.,

JOSEPH HENRY, Director, S. I.

Endorsement on Royal Society circulars.

SMITHSONIAN INSTITUTION.

"Washington, D.C., November, 1875.

"The Smithsonian Institution begs leave to call special attention to this circular, and to suggest that it will cheerfully take charge of any packages which you may desire to send to the Royal Society of New South Wales."

JOSEPH HENRY, Secretary, S.I.

SMITHSONIAN INSTITUTION.

Washington, 18 November, 1875.

Dear Sir,—Your letter addressed to Mr. Williams, Consul of the United States to New South Wales, was referred to this Institution, and it gives me pleasure to inform you that we will cheerfully co-operate with you in effecting an exchange between Societies in this Country and the Royal Society of New South Wales. The Smithsonian Institution, as you are probably aware, has established a great system of international exchange, through which most of the scientific publications of the United States, of Canada, and of South Central America, are distributed to different parts of the world. Our intercourse with Australia is through our Agent in London, Mr. W. Wesley, 28, Essex-street, Strand, to whom we would request you to send, addressed to us, anything you may desire distributed in the American Countries abovementioned. Besides publications, we are desirous, on our own part, to obtain objects of Natural History and Ethnology. Your circular will be distributed to the leading Scientific Societies of this Country, and especial attention will be called to it by an accompanying letter.

Respectfully and truly yours,

JOSEPH HENRY, Director, S.I.

PROFESSOR LIVERSIDGE,
Hon. Secretary, Royal Society, N.S.W., Sydney.

CONSULATE OF THE GERMAN EMPIRE.

Sydney, 10 May, 1876.

Sir,—With reference to your letter of 6th July, 1875, in which you informed me that the Royal Society of New South Wales was desirous of being placed in communication with similar Scientific Societies and Institutions in Germany, and in which you forwarded to me copies of the Fundamental Rules and other information relating to the Society, I have the honor to hand to you herewith translation of a letter bearing on this subject, which I received from the Foreign Office, Berlin, in reply to my report, and also beg to forward you 167 volumes, and two charts, as particularised in the list, enclosed herewith. The communication which has thus been established through the diplomatic channel between the Royal Society and the leading scientific Societies of Germany, will I trust be a permanent one, and of mutual advantage.

I have, &c.,

CARL L. SAHL, Imperial German Consul.

PROFESSOR LIVERSIDGE,
Hon. Secretary, Royal Society, Sydney.

FOREIGN OFFICE, BERLIN.

1 March, 1876.

Sir,—Referring to your report of 9th July, 1875, in which you intimate that the "Royal Society of New South Wales" wishes to enter into closer connection with Scientific Societies and kindred Institutions, for the purpose of interchanging publications of scientific tendencies, I have the honor to inform you that I have brought this under the notice of the Governments of Prussia, Bavaria, Saxony, Württemberg, Baden, and Sachsen Weimar, and now acquaint you with the result, so that you may take any further steps necessary.

With reference first to the SCIENTIFIC INSTITUTIONS of Prussia.

"The Royal Academy of Science" here (Königliche Akademie der Wissenschaften) has resolved to forward to the "Royal Society" their Monthly Report from the year 1860.

"The Royal Society of Science in Göttingen" (Königliche Gesellschaft der Wissenschaften in Göttingen), which is already exchanging publications with the Royal Society of Victoria, in Melbourne, is ready to enter into similar relations with the Royal Society of New South Wales, and from its publications it has sent in "The Communications of the Society of Sciences and the George Augustus University" (Nachrichten von der Gesellschaft der Wissenschaften und der Georg August Universität) for 1875, which contain principally transactions of their meetings, and communications on subjects of Natural Sciences and Mathematics, and of Historical and Philological interest.

"The Society of Natural History in Görlitz" (Naturforschende Gesellschaft in Görlitz) has also declared itself willing to exchange publications, and for this purpose has sent in three volumes of its present Report of Proceedings, as well as three volumes from a former period.

"The Society of Natural History of Prussian Rhinelands and Westphalia in Bonn (Naturhistorische Verein der Preussischen Rheinlande und Westphalens in Bonn) has some time ago expressed its readiness to Dr. LEIBIUS of the Royal Society, through its Secretary, Professor Andrä, to exchange publications, and has sent in a packet of publications under his address.

"The Society of Physics and Agriculture in Königsberg in Prussia" (Die Physikalisch-oeconomische Gesellschaft in Königsberg i/Pr.), as well as the "Geographical Society in Hamburg" (die geographische Gesellschaft in Hamburg), have also declared themselves ready to exchange publications, and the latter has sent in its two first Annual Reports of the year's proceedings.

"The Senckenberg Society of Natural History in Frankfurt a/M," (Senckenbergische naturforschende Gesellschaft in Frankfurt a/M) will enter into direct negotiations with the Royal Society, and fulfil their wishes.

From the ROYAL BAVARIAN GOVERNMENT.

I have been informed that the "Royal Academy of Science in Munich" (Königlische Akademie der Wissenschaften in München) is prepared to connect itself with the Royal Society, and to exchange with it its publications referring to Mathematical and Physical subjects (mathematisch physikalische Klasse). As to the other Scientific Societies of Bavaria which publish scientific books, the following nine are mentioned, and the Royal Society can, if they deem it advisable, put themselves in direct communication with them :—

1. "The Society of Natural History in Augsburg" (der Naturhistorische Verein in Augsburg). Publishes reports.
2. "The Society of Natural History in Bamberg" (die Naturforschende Gesellschaft in Bamberg). Publishes reports.
3. "The Pollichia in Deidesheim, Bavarian Palatinate" (die Pollichia in Deidesheim, Bayer. Pfalz). Reports.
4. "The Botanical Society in Landshut" (der Botanische Verein in Landshut). Reports.
5. "The Society of Natural History in Nürnberg (die Naturhistoriche Gesellschaft in Nürnberg). Reports.
6. "The Botanical Society in Regensburg" (die Botanische Gesellschaft in Regensburg). Botanical reports.
7. "The Zoological and Mineralogical Society in Regensburg" (der Zoologisch-mineralogische Verein in Regensburg). Paper for correspondents and reports.
8. "The Society of German Apothecaries in Speyer" (der Deutsche Apotheker Verein in Speyer). Yearly volume for Pharmacy..
9. "The Physical-Medical Society in Würzburg" (die Physikalisch-Medizinische Gesellschaft in Würzburg). Reports.

According to a communication from the ROYAL GOVERNMENT OF WURTTEMBERG,

"The Society of Natural Science in Württemberg" (der Verein für Vaterländische Naturkunde in Württemberg), at Stuttgart, is prepared with pleasure to connect itself with the Royal Society. This Society publishes every year three editions, with plates of subjects interesting to Natural History, and is prepared to exchange the publications from the year 1866, if the Royal Society will send its publications from the year of its foundation, 1866, and further annual publications. If the Royal Society should like to exchange objects of Natural History or dispose of them by sale, the Royal Cabinet of Natural History in Württemberg (Königlich Württembergisches Naturalien Kabinet) would be glad to enter into negotiations.

Also the Royal Bureau for Statistics and Topography at Stuttgart (Königlich Statistich-Topographisches Büreau zu Stuttgart) is prepared to connect itself with the Royal Society, and exchange publications. This Society is principally concerned with Statistics and Meteorology, and the two publications sent herewith give further information.

From the ROYAL GOVERNMENT OF SAXONY,

I have received a list of the following Societies which would be willing to be connected with the "Royal Society:"—

"The General Directorship of Royal Collections for Arts and Sciences in Dresden" (General-Direction der Königlichen Sammlungen für Kunst und Wissenchaft zu Dresden).

"The Statistical Bureau of the Ministry of the Interior at Dresden" (das Statistische Büreau des Ministeriums des Innern zu Dresden).

"The Imperial Leopold Caroline German Academy of Natural History at Dresden" (die Kaiserlich Leopoldinisch-Carolinisch Deutsche Akademie der Naturforscher zu Dresden).

"The Academy of Mines at Freyberg" (die Berg Akademie zu Freiberg).

Of the collection of publications bearing on Natural History, which the General Directorship of the Royal Collections intend to send regularly in future to the Royal Society, a number of publications have been sent, as per list herewith.

In the GRAND DUCHY of BADEN there are four Societies of Natural Science:—

1. "Society of Natural Science at Carlsruhe" (Naturwissenschaftlicher Verein zu Carlsruhe).
2. "Society of Natural Science" at Mannheim (Mannheimer Verein für Naturkunde).
3. "Society of Natural Science" at Freiburg (Naturforschende Gesellschaft zu Freiburg).
4. "Society of Natural History and Medicine" at Heidelburg (Naturhistorisch Medicinische Gesellschaft zu Heidelberg).

Only the first and third of the above Societies have so far decided to connect themselves with the Royal Society, and the Reports for the years 1870–73 of the Society of Natural Science are sent herewith.

Finally, I wish to mention that the "Society of Medicine and Natural Science," at the University of Jena (die Medizinisch Naturwissenschaftliche Gesellschaft der Universität Jena) has resolved to send to the Royal Society regularly a copy of their Jena Pamphlet for Natural Science, (Jenaische Zeitschrift fur Naturwissenschaft), and thus enter into the desired connection with that Society.

THE CHANCELLOR,

By order,

B. BULOW.

To CARL L. SAHL, ESQ.,

Imperial German Consul, Sydney.

LIST OF BOOKS FOR THE ROYAL SOCIETY.

"Königliche Akademie der Wissenschaften, Berlin." Monthly reports from 1860. 146 volumes.
"Nachrichten von der Gesellschaft der Wissenschaften, and der G. A. Universität, 1875." 1 volume.
"Naturforschende Gesellschaft in Görlitz." 6 volumes, 2 charts.
"Geographische Gesellschaft, Hamburg." 2 reports.
"Königlich statistisch-topographisches, Bureau." 2 reports.
"Naturforschende Gesellschaft, Freiburg." 4 Reports 1870–73.
"General Directorship of Royal Collection for Arts and Science, Dresden": (1) Die Urnenfelder von Strehlen. (2) Geologie von Sumatra. (3) Der Arabische Himmelsglobus. (4) Mittheilungen aus dem Königl. Geol. Museum, Dresden. (5) Mittheilungenüber die Sammlungen des Königl. Mathem-Physikal. Salons. (6) Katalog der Sammlungen der Königl. Mathem. Physikalischen. Salons.

167 volumes and 2 charts.

German Consulate, CARL L. SAHL, Consul.
Sydney, May 10, 1876.

MUSEUM OF NATURAL HISTORY.

Paris 27, January 27, 1876.

A letter from Professor E. CHEVREUL, Director, acknowledging the receipt of eight volumes of the Transactions of the Royal Society of N.S.W., from 1867 to 1874, and promising to transmit to the Society a collection of ethnological photographs which is in preparation.

The Rev. WM. SCOTT referred to the suggestions in the Address of the Chairman, as to seeking a grant from the Government: they were entering on enlarged expenditure, and would need help.

Mr. H. C. RUSSELL thought they might obtain Government aid if they represented the case properly. There was no Library in the Colony that might be called a Scientific Library; that was one of their requirements. A Committee should be appointed to form a deputation to the Government on the subject.

Mr. TREBECK recommended the appointment of such deputation, and suggested that an annual endowment would be more serviceable than a large sum.

Mr. BENSUSAN thought that they should now ask for a fixed sum to stock their Library.

After some further discussion, it was moved by Mr. H. C. RUSSELL, seconded by Mr. WM. NEILL, and carried:—That the following members of the Society, viz., The Hon. Francis Lord, M.L.C., the Hon. John Hay, M.L.C., Rev. Dr. Lang, Rev. W. B. Clarke, Professor Liversidge, Dr. Leibius, Rev. Wm. Scott, John Squire Farnell, Esq., M.P., Charles Moore, Esq., and the mover, be appointed a Committee to seek assistance from the Government, and that the manner in which this assistance will be asked shall be left to the Committee.

It was then decided that the Committee should meet at the Rooms on Monday next, at 4 p.m.

WEDNESDAY, 7TH JUNE, 1876.

Ordinary monthly meeting of the Royal Society of New South Wales, held in the Society's Rooms, Elizabeth-street.

The Rev. W. B. CLARKE, V.P., in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society, viz.:—

Rev. W. F. Roberts, B.A.	A. S. Webster.
George Evans.	Houlton H. Voss.
W. F. M'Carthy.	Henry James Brown.
The Hon. Saul Samuel, C.M.G., M.L.C.	John Eales.
	John V. Dalgarno.
H. E. Southey.	W. H. M'Guire.
Rev. E. M. Saliniere.	Walter Hugh Tibbits.
H. Arding Thomas.	Rev. P. F. Mackenzie.
W. A. Murray.	J. M. Marsh, P.M.

Twelve new candidates were proposed and seconded.

The CHAIRMAN reported to the members that the Committee, appointed at the last meeting for the purpose of seeking assistance from the Government, had waited as a deputation upon the Honorable the Minister for Justice and Public Instruction on the 26th inst., and had submitted a request to be communicated to the Government for the sum of £2,500, for the erection of a suitable building, and £300 annually for the ordinary purposes of the Society.

The deputation was courteously received, and the Minister promised to bring the matter before his colleagues.

MEMORANDUM subsequently forwarded to the Honorable the Minister for Justice and Public Instruction:—

Reasons for the Application for Assistance.

1. *Popular scientific lectures*—To enable the Society to institute courses of popular scientific lectures.

2. *Working Sections*—To permit the establishment of working Sections of the Society for the promotion of special branches of science.

3. *Scientific library*—To enable the Society to form a library of standard scientific works.

4. *To collect and distribute publications*—To found a central institution in New South Wales for the exchange of scientific publications between the Institutions of this Colony and those of other countries. Recent experience has shown that the Transactions of this Society will be received as an equivalent for the publications of most of the leading Societies of Europe and America.

5. *Scientific investigations*—In England similar scientific Societies afford valuable information to the Government on many subjects. The Royal Society of Sydney has done something in the past, and is anxious to do more in the future.

6. *Insufficient funds*—The money at its disposal will not permit the Society to maintain even its present relations with the public and other Societies, and it is totally inadequate to carry out the contemplated extended scheme of usefulness.

7. £5,000 *subscribed—Assistance sought*—Since its commencement, the Society has subscribed upwards of £5,000 for the promotion of science and higher education in the Colony, and the undersigned now respectfully ask in the name of the Society for assistance from the Government, in order that they may make their past labours and present capabilities of more use to the public. The principal English scientific Societies are provided with suitable accommodation, Burlington House having been recently rebuilt at great cost expressly for this purpose; and the Royal Society of London has large sums of money annually placed at its disposal by the Government.

Other Societies receive aid—They feel that they are justified in making this request, because other Societies established here to educate and instruct the public receive grants of money and assistance.

Societies in other Colonies—The corresponding Societies in Victoria, New Zealand, and Tasmania, are liberally supported and provided with suitable buildings by their respective Governments.

Under these circumstances the undersigned members were appointed a deputation to wait upon the Minister for Justice and Public Instruction to request him to take the case of the Royal Society of New South Wales into his favourable consideration, and to obtain for it an annual grant equal to the subscriptions, and to provide it with suitable buildings, or a money grant to help in securing such building or other accommodation for lecture-rooms, library, and offices :—

Signed:—	W. B. Clarke.	A. Lang.
	H. C. Russell.	C. Moore.
	Francis Lord.	A. Leibius.
	J. S. Farnell.	A. Liversidge.

The new Bye-laws brought forward by the Council were read *seriatim* by the CHAIRMAN, and were adopted.

Several donations were laid upon the table.

A letter was read from Mr. Ellery, Government Astronomer of Victoria, acknowledging the honorary membership conferred upon him.

It was then decided that the preliminary meetings of the various Sections should take place in the Society's Rooms on the following dates, at 8 p.m., viz.:—

Section	A—Astronomy, &c.	June 19
,,	B—Chemistry, &c.	,, 20
,,	C—Geology, &c., Temp. Amal. with B	,, 21
,,	D—Biology (To be arranged.)	,, 22
,,	E—Microscopy	,, 23
,,	F—Geography	,, 26
,,	G—Literature and Fine Arts	,, 27
,,	H—Medical	,, 28
,,	I—Sanitary and Social	,, 29

Mr. H. C. RUSSELL then read a paper entitled "Notes on some remarkable errors shown by Thermometers."

Mr. H. C. RUSSELL also exhibited an improved form of Heliostat for signalling.

After a few remarks from the Rev. WM. SCOTT the meeting adjourned until the 5th July.

WEDNESDAY, 5TH JULY, 1876.

Ordinary monthly meeting of the Royal Society of New South Wales, held in the Society's Rooms, Elizabeth-street.

The Rev. W. B. CLARKE, V.P., in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society, viz. :—

William George Tayler, F.R.C.S., London, 219, Pitt-street.
W. H. Eldred, 119, Castlereagh-street.
Archibald Atcheson, North Shore.
William Hedley Drake, Commercial Bank, Inverell.
The Hon. Alexander Campbell, M.L.C., Woollahra.
W. A. Brodribb, Riverina.
W. O. Gilchrist, Union Club.
James Osborne, Wollongong.
William Forde, 4 Carlton Terrace, Wynyard Square.
Henry Heron, William-street South.
Thomas S. Parrott, Ashfield.
John Leo Watkins, B.A., Randwick.

The certificates of thirty candidates were read.

The Honorary Treasurer drew the attention of members to the 15th Bye-law, providing for the posting up in the Rooms of the Society of the names of members who are in arrears with their annual subscriptions, and stated that he had not prepared the list for this meeting because the new Rules were only passed in June, but that in future this Bye-law would be strictly enforced.

Professor LIVERSIDGE then gave an account of the meetings of the several Sections according to appointments made at the last meeting of the Society. Section C, on Geology and Palæontology, had been amalgamated with Section B, on Chemistry and Mineralogy. It had also been decided by the Council that Section H should include Medical Science only; and that Section I should include Sanitary and Social Science and Statistics.

Professor LIVERSIDGE further reported that the following gentlemen had been elected officers of the undermentioned Sections, viz. :—

Section A—Astronomical and Physical Science.—Chairman: H. C. Russell, B.A., F.R.A.S. Committee: G. D. Hirst, H. A. Lenehan, Rev. W. Scott, M.A., and Dr. Wright. Secretary: J. M'Donald, F.R.A.S.

Section B—Chemistry and Mineralogy, with which is incorporated Section C—Geology &c.—Chairman: Professor Liversidge. Committee: S. L. Bensusan, J. W. M'Cutcheon, J. S. Sleep, W. F. Tulloh. Secretary, W. A. Dixon, F.C.S.

Section E—Microscopy.—Chairman: A. Roberts, M.R.C.S. Committee: Dr. Milford, Dr. Belgrave, W. MacDonnell, Hugh Paterson. Secretary: G. D. Hirst.

Section F—Geography, &c.—Chairman: E. Du Faur, F.R.G.S. Committee: Hon. L. De Salis, M.L.C., J. Manning, C. L. Sahl, A. S. Webster. Secretary: W. Forde.

Section G—Literature and Fine Arts.—Chairman: E. L. Montefiore. Committee: Hon. L. De Salis, M.L.C., E. Du Faur, F.R.G.S., W. G. Murray, C. A. Morell. Secretary: H. A. Lenehan.

Section H—Medical Science.—Chairman: A. Roberts, M.R.C.S. Committee: Dr. Milford, Dr. Morgan, Dr. Cox, H. G. Wright, M.R.C.S. Secretary: Dr. Sydney Jones.

Section I—Sanitary and Social Science had not yet met to elect officers.

Twelve donations were laid upon the table by the Chairman.

The Rev. Dr. Lang then read his paper—"On the Origin and Migration of the Polynesian Nation, and their original discovery, possession, and settlement of America; with a critical examination of Mr. Bancroft's work upon the Native Races of the Pacific States of North America."

Mr. H. C. Russell, the Government Astronomer, exhibited a clock with an appliance for correcting the time every hour, by means of an electro-magnet connected with a regulator. This method had been invented by Mr. Russell for the purpose of regulating the clock at the Railway Terminus, Redfern, by the standard clock at the Observatory.

THURSDAY, 20 JULY, 1876.

Extra Meeting of the Royal Society of New South Wales, held in the Society's Rooms, Elizabeth-street.

The Revd. W. B. Clarke, V.P., in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary Members of the Society, viz.:—

Arthur Todd Holroyd, M.D., M.B. (Cantab), F.L.S., F.R.G.S., Sherwood Scrubs, Parramatta.

The Hon. Wm. Graham, M.L.C., Union Club, Sydney.

Alfred Cadell, Vegetable Creek, New England.

J. T. Toohey, Melrose Cottage, Cleveland-street.

James Burleigh Sharpe, J.P., Yass.
Rev. Frank Firth, Newcastle.
George Foster Wise, Darlinghurst.
Rudolf Schütte, M.D., Univ. Göttingen, Lic. Soc. Apoth., Lond., 10, College-street.
Thomas Henry Gilman, M.D., Queen's Univ. Irel., Mast. Surg. Queen's Univ. Ire., Lic. Mid. K. & Q. Coll. Phys. Irel., College-street.
Wm. Gillett Sedgwick, M.R.C.S. England, Newtown.
Thos. Stackhouse, Commander R.N., Australian Club.
Henry Norman Maclaurin, M.D., Univ. Edin. Lic. R. Coll. Sur. Edin., Lic. Mid. R. Coll. Sur. Edin., 187, Macquarie-street.
Fredk. Norton Manning, M.D. Univ. St. And., M.S.C.S. Eng., Lic. Soc. Apoth., Lond., Gladesville.
Louis Thos. Laure, M.D., Surg. Univ. Paris, 181, Castlereagh-street.
Allan Bradley Morgan, M.R.C.S., Eng., Lic. Mid. Lic. R. Coll. Phys., Edin., Burwood.
Fredk. Harrison Quaife, M.D., Univ. Glas., Mast. Surg. Univ. Glas., Piper-street, Woollahra.
Wm. Conder, Survey Office, Sydney.
W. C. Windeyer, M.A., M.L.A., King-street.
F. H. Trouton, A.S.N. Company's Offices, Sydney.
Chas. Kinnard Mackellar, M.B., C.M. (Glas.), Lyons' Terrace.
George Marshall, M.D., Univ. Glas., Lic. R. Coll. S., Edin. Lyons' Terrace.
Andrew John Brady, Lic. K. & Q. Coll. Phys., Irel., Lic. Mid. K. & Q. Coll. Phys., Irel., Lic. R. Coll. Sur., Irel., Sydney Infirmary.
Charles M'Kay, M.D., Univ. St. And., Lic. R. Coll. Surg., Edin., Church Hill.
Thos. Wm. Keele, Harbours and Rivers Department, Phillip-street.
Michael Joseph Clune, Lic. K. & Q. Coll. Phys. Irel., Lic. R. Coll. Surg. Irel., 4 Hyde Park Terrace.
Benjamin Fyffe, M.R.C.S., England, Castlereagh-street.
John Wilson Alston, M.B., Edin., Mast. Surg. Edin., 455, Pitt-street.
Wm. James Barkas, Lic. R. Col. Phys. Lon. M.R.C.S., Eng., Bombala.
Henry William Jackson, L.R.C. Surg., Edin., Lic. R. Phys., Edin., 130, Phillip-street.
John Cash Neild, M.D., Sydney, M.R.C.S., Eng., Lic. Soc. Apoth., Lon.

The certificates of nineteen new candidates were proposed and seconded.

In reference to the books and periodicals of the Society, the Chairman announced to the meeting that the Council had passed the following minute, viz.:—"That the books and periodicals of the Royal Society of New South Wales can not be open to the members generally until the Society has rooms of its own in which proper convenience for reading can be provided."

Professor LIVERSIDGE reported that Section I—Sanitary and Social Science—had been established since the last meeting, and that the following gentlemen had been elected officers of the Section, viz.:—Chairman, A. Roberts, M.R.C.S.; Committee, J. G. Bedford, M.R.C.S., Dr. Morgan, W. Tarleton, H. H. Voss; Secretary, Harrie Wood; and that the days for the sectional meetings would be as follows:—

		July.	Aug.	Sept.	Oct.	Nov.	Dec.
Section A—Astronomy, &c.	Wednesday ...	26	30	27	25	29	27
„ B—Chemistry, &c.	Wednesday......	12	9	13	11	8	13
„ C—Geology, &c., Temp. Amal. with B.							
„ D—Biology (To be arranged).							
„ E—Microscopy.	Wednesday.........	19	16	20	18	15	20
„ F—Geography.	Monday...............	17	21	18	16	20	18
„ G—Literature & Fine Arts.	Monday	24	28	25	23	27	25
„ H—Medical.	Thursday		10	14	12	9	14
„ I—Sanitary and Social.	Tuesday...	11	8	12	10	14	12

Twenty donations were laid upon the table.

The Revd. DR. LANG then read the concluding portion of his paper "On the Origin and Migration of the Polynesian Nation, and the Original Discovery, Possession and Settlement of America, with a critical examination of Mr. Bancroft's work upon the Native Races of the Pacific States of North America."

The Rev. W. B. CLARKE then read a paper "On Deep Submarine Depressions off Moreton Bay."

Mr. H. C. RUSSELL exhibited and explained one of Crooke's Radiometers which he had just received from England.

WEDNESDAY, 2 *AUGUST,* 1876.

Ordinary monthly meeting of the Royal Society of New South Wales, held in the Society's Room's Elizabeth-street.

The Rev. W. B. CLARKE, V.P., in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary Members of the Society:—

W. E. Langley, *Herald* Office, Sydney.
Benjamin Backhouse, Elizabeth Bay.
J. Waterhouse, M.A. (Sydney), Newington College, Parramatta.
Thos. R. Icely, Carcoar.

Richard Lewis Jenkins, M.R.C.S., Nepean Towers, Douglass Park.
Douglas Dixon, Australian Club.
Richard Frean, Sydney Infirmary.
Myles Egan, Surgeon, 2 Hyde Park-terrace, Liverpool-st.
Wm. Edmund Strong, M.D., Liverpool.
Andrew Robertson Cameron, Physician, Richmond.
W. Lyons, Woollongong.
Chas. Henry Myles, Wymela, Burwood.
C. Russell Watson, Surgeon, Newtown Road, Newtown.
Owen Spencer Evans, Surgeon, Darling-street, Balmain.
Richard P. Jones, M.D., Ashfield.
James Douglas, Surgeon, Glebe Road, Glebe.
Gordon Davidson, M.D., Goulburn.
Isaac Waugh, M.B., T.C.D., Parramatta.
Allan Campbell, Surgeon, Yass.

The certificates of nineteen new candidates were read.

A letter was read from the Literature and Fine Art Section, which that Section intended to address to the Colonial Secretary, urging upon the Government the desirability of introducing the Woodbury process of Photography into this Colony, for the purpose of keeping an authentic and permanent record of Colonial maps and scenes. It was stated that the process could be obtained for £300.

Mr. H. C. Russell said it was thought that the letter would have more weight if it were signed by the members of the Society generally, and it was accordingly brought to the meeting for that purpose.

Twenty-eight donations were laid upon the table.

Mr. G. D. Hirst then read his paper, entitled "Notes on Jupiter during his opposition, 1876," which he illustrated with numerous drawings.

The Rev. W. B. Clarke laid on the table, for the inspection of the members, one of the curious chipped stones supposed to have been shaped by the primitive inhabitants of Europe, and which had been sent to him from Belgium.

WEDNESDAY, 6th SEPTEMBER, 1876.

Ordinary monthly meeting of the Royal Society of New South Wales, held in the Society's Rooms, Elizabeth-street.

The Rev. W. B. Clarke, V.P., in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary Members of the Society:—

E. G. Tennant, M.R.C.S.E., Orange.
Thos. Cecil Morgan, Lic. R.C.S.E., L.M.R.C.S., Ireland, Australian Club.
F. B. Gipps, Strathspey House, Macquarie-street.
George Goodie, M.B., Univ. Dub., Camden.
W. F. Bassett, M.R.C.S.E., Bathurst.
Chas. Parbury, Union Club.
John Shields, M.R.C.S., Ed., Bega.
W. H. Quodling, Burwood.
Rev. Henry Shaw Millard, Newcastle Grammar School.
Henry Sharp, Green Hills, Adelong.
Rev. George Martin, Newtown.
E. H. C. Bristowe.
A. H. M'Culloch, jun., 165, Pitt-street.
Wm. Smith Thomas, M.R.C.S.E., Wollongong.
James Aberdeen Jones, Lic. R.C. Phys., Edin., Balmain.
John Fredk. Codrington, M.R.C.S.E., Lic. R.C. Phys., L.; Lic. R.C. Phys., Edin.
Saml. Fredk. Tollett Milford, M.R.C.S.E., M.B. Univ. Heidelberg, College-street.
J. P. Josephson, 253 Macquarie-street North.
Samuel Bennett, Little Coogee.

The certificates of four new candidates were read.

Fourteen donations were laid upon the table.

The first of a series of papers by Mr. Barkas, M.R.C.S., "On the genus Ctenodus of the Coal Measures of Great Britain," was read by Mr. Edward Ramsay, in the absence of the author.

The paper was illustrated by drawings.

Professor LIVERSIDGE then read his paper "On the formation of Moss Gold," which he illustrated by numerous specimens.

Teeth of the Ceratodus from Würtemberg were exhibited by the Rev. W. B. Clarke.

WEDNESDAY 4TH OCTOBER, 1876.

Ordinary monthly meeting of the Royal Society of New South Wales, held in the Society's Rooms, Elizabeth-street.

H. C. RUSSELL, V.P., in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society, viz.:—

Wm. Hoxton Hayley, M.R.C.S., Ed., Goulburn.
Clarendon Stuart, Upper William-street, South.
Chas. Marshall Fisher, 173, Pitt-street.
Thos. Pickburn, M.B., Aberdeen, College-street.

Seventeen new candidates were proposed and seconded, including seven members of the Sydney Botanical Society.

Communications from the Sections.

Section A. ASTRONOMY. Mr. H. C. RUSSELL read extracts from the *Gazette* of Thursday, June 30th, 1836, from the *Colonist* of Thursday, 30th June, 1836, and from the *Australian* of Tuesday, July 5th, 1836, in reference to a heavy fall of snow in Sydney, on Tuesday morning, the 28th June, 1836.

Section I. SANITARY AND SOCIAL SCIENCE. Mr. ALFRED ROBERTS submitted a Report from the above Section, which, as the result of its deliberations, had adopted the following resolution, viz. :—

That the Royal Society of New South Wales be invited by this Section to wait upon the Government by deputation and urge it to introduce during the next Session an efficient General Public Health Act, and to appoint a Central Board with ample powers to enforce its provisions.

In pursuance of the above resolution, Mr. ALFRED ROBERTS moved.

That a deputation of this Society, consisting of the following gentlemen, viz. :—

The Vice-Presidents and the Secretaries.

Alger John, Esq.,
Allen The Hon. George Wigram, Esq., M.L.A.
Belgrave Dr.
Burton Edmund, Esq.
Cox Dr.
Dangar F. H., Esq.
Dibbs G. R., Esq., M.L.A.
DeSalis The Hon. Leopold Fane, M.L.C.
Fairfax The Hon. John, M.L.C.
Farnell J. S., Esq., M.L.A.
Goodlet John H., Esq.
Hay The Hon. John, M.L.C.
Holt, The Hon. Thos., M.L.C.
Jones Dr. Sydney
Knox Edward, Esq.
Lord The Hon. Francis, M.L.C.
Lloyd G. A., Esq., M.L.A.
Manning James, Esq.
Mansfield G. A., Esq.
Milford Dr.
Morgan Dr. C. W.
Murray W. G., Esq.
M'Lauren Dr.
Neill Wm., Esq.
Neild Dr.
Pell Professor, B.A.
Smith Professor, M.L.C.
Scott Rev. W., M.A.
Spencer W., Esq.
Roberts Alfred, Esq.
Trebeck P. N., Esq.
Ward Dr.
Weigall A. B., Esq., B.A.
White Hon. Jas., M.L.C.
Wood Harrie, Esq.
Wright H. G. A., Esq.

And such other members as shall be willing to attend, be appointed to wait upon the Government to urge it to introduce during the next Session an efficient General Public Health Act, and to appoint a Central Board with ample power to enforce its provisions.

The above resolution was seconded by Mr. WM. NEILL, and carried.

Ninety-seven donations were laid upon the table, and thanks were ordered for them.

A Paper "On the Microscopic Structure of the Teeth of Ctenodus" by Mr. BARKAS, M.R.C.S., was read by Professor LIVERSIDGE.

Mr. S. L. BENSUSAN then read his paper "On recent Copper-extracting Processes."

A paper by the Rev. J. E. TENISON WOODS, F.G.S., F.L.S., "On some Tertiary Australian Polyzoa, illustrated by Drawings," was read by Professor LIVERSIDGE.

The Chairman then exhibited a Thermo-Electric Battery, and illustrated its utility by a variety of experiments.

The reading of Mr. Russell's paper "On Meteorological Periodicity" was postponed until the 13th of October.

The meeting then adjourned until the 13th instant.

FRIDAY, 13TH OCTOBER, 1876.

Extra meeting of the Royal Society of New South Wales, held in the Society's Rooms, Elizabeth-street.

The Rev. W. B. CLARKE, V.P., in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society, viz.:—

F. Ratte, Noumea, New Caledonia.
Henry Toller Wilkinson, Department of Mines.
Thomas Brown, Eskbank, Bowenfels.
Rev. Dr. J. A. Quirk, O.S.B., LL.D., Sydney, Lyndhurst College.
J. H. Heaton, Pitt-street.
Fredk. C. Jarrett, 292, George-street.
Dr. Rowling, Mudgee.
Wm. Henry Suttor, J.P., Caugoura, Bathurst.
Clement A. Benbow, 24, College-street.
James Henry Brown, Moncur-street, Woollahra.
R. S. Smith, Surveyor General's Office.
J. D. Reece, Surveyor General's Office.
Arthur J. Stopps, Surveyor General's Office.
R. D. Fitzgerald, F.L.S., Surveyor General's Office.
Aroid Nilson, Department of Mines.
W. D. Armstrong, Surveyor General's Office.
F. B. W. Woolrych, 38, Cumberland-street.

The certificates of four new candidates were read.

Two donations were laid upon the table.

Mr. H. C. RUSSELL then read his paper on "Meteorological Periodicity."

A discussion ensued, in which Professor Smith, the Hon. Leopold Fane de Salis, Mr. Du Faur, Dr. Belgrave, and the Chairman took part.

WEDNESDAY, 1ST NOVEMBER, 1876.

Ordinary monthly meeting of the Royal Society of New South Wales, held in the Society's Rooms, Elizabeth-street.

The Rev. W. B. CLARKE, V.P., in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society, viz.:—

W. R. George, 172, Castlereagh-street.
Ernest Docker, Macleay-street.
Bernard Austin Freehill, 130, Elizabeth-street.
George Frederick Dansey, M.R.C.S., London, York and Margaret Streets, Wynyard Square.

Five new candidates were proposed and seconded.

PUBLIC HEALTH ACT.

Mr. H. C. RUSSELL stated that at the last meeting a deputation was appointed by the Society to wait on the Colonial Secretary, for the purpose of urging him to introduce some measure for the improvement of the sanitary condition of the city. The deputation saw the Honorable the Colonial Secretary on the 31st October, and he informed them that if the Society would undertake to prepare a Bill he would assist and if possible get it passed. Mr. Russell further stated, that though this was not a subject that he had thought much of, he considered the Society ought to do all in their power to get a Bill passed that would remove all offensive things from their streets. It might be thought that in framing a Bill the Society would be taking upon them in some sort a political duty. That was a matter that ought to be carefully looked at. But still he felt so much the desirability of pressing the matter forward that he would move the following resolution:—"That the request of the Honorable Colonial Secretary, conveyed through the deputation which waited on him on the 31st ultimo, to urge the necessity for passing a Public Health Bill be complied with, and that a Committee, consisting of the Chairman and Secretaries of the Medical and Sanitary Sections, W. G. Murray, Esq., and the Honorary Secretaries of the Society, be appointed to prepare, with the Parliamentary Draftsman, a Public Health Bill; and that such Committee be empowered to sit during the prorogation of the Society's session, and to submit such Bill to the Colonial Secretary when completed."

Mr. ROBERTS said that the Colonial Secretary had offered the Society the services of a Parliamentary Draftsman and of the Government Printer to aid them. That appeared to him to show the Colonial Secretary's earnestness in the work, and he for one felt that he could see the way clear before the Society to do a great good to the community. He saw the difficulty mentioned by Mr. Russell; but this appeared to him to be an exceptional case, and one that was hardly political in its character. He thought they might perhaps get over the difficulty by appending to Mr. Russell's resolution words in effect disavowing any political object on the part of the Society, and stating that it was only in view of the sad condition of the Colony, and in the cause of humanity, that it determined to take the work up. The work would no doubt be very arduous. It required special knowledge, and there was no other body that he was aware of equally capable of dealing with it, except the Sewage and Health Board. He should personally be glad to be relieved from the work, but he would not shirk it if it were felt to be desirable.

The Honorable FRANCIS LORD seconded the resolution.

Dr. BELGRAVE and Mr. Murray spoke in favour of the resolution.

Mr. CHARLES MOORE and the Rev. WM. SCOTT opposed the resolution.

Professor LIVERSIDGE did not think the Society should interfere in any way whatever with legislation. They might give some general suggestions to the Government, and what was done had better be done by the Sections of the Society—by the Committees of the Sanitary and Medical Sections.

The CHAIRMAN also thought that the matter had better be left with the Sections.

The Rev. Mr. SCOTT moved, as an amendment, the omission of all the words after the word "be," with the view to insert the following words—"requested to draw up a series of suggestions to be submitted to the Government with a view to the preparation of such Bill."

Dr. NEILD seconded the amendment. He thought that whatever was done by the Sections of the Society would be regarded as done by the Society itself.

Mr. ROBERTS said, that if they confined their action to merely giving a few suggestions the matter would fall through.

The amendment was then put to the meeting from the Chair, and negatived, and the resolution was carried.

Mr. H. C. RUSSELL then moved, "That the Secretary be directed to inform the Colonial Secretary of the foregoing resolution, and to request that a Parliamentary Draftsman be appointed to act with the Committee."

The motion was seconded by Dr. BELGRAVE, and carried.

Three donations were laid on the table, and the thanks of the Society ordered for them.

The following papers were received from Mr. Barkas, M.R.C.S:

"On the Microscopical structure of the Teeth of Ctenodus," Part 3; and

"On the Dentary, Articular, and Pterygo-palatine Bones of Ctenodus," Part 4.

The Rev. W. B. Clarke then read his paper "On the effects of Forest Vegetation on Climate."

A discussion ensued in which Mr. Charles Moore and the Chairman took part, and the further discussion of the paper was adjourned until the next meeting.

Exhibits.

Mr. W. M'Donald exhibited and explained the action of Tate's new form of air-pump.

Mr. Colyer exhibited a specimen of coral, which was of special interest, inasmuch as it had been found by the cable-ship "Edinburgh," adhering to the cable laid between Port Darwin and Banjowangie, about 270 miles from Port Darwin, and taken from a depth of 150 feet. The coral was three or four inches in thickness, and bore the marks of the cable, which it had overgrown to the extent named.

WEDNESDAY, 6th DECEMBER, 1876.

Ordinary monthly meeting of the Royal Society of New South Wales, held in the Society's rooms, Elizabeth-street.

The Rev. W. B. Clarke in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary Members of the Society, viz.:—

George B. Montefiore, 5, Gresham-street.
John Martin, Ryde.
Wm. Christie, L.S., Hawthorn Lodge, Glen Innes.
A. W. Scott, M.A. (Cantab), Ferndale, New South Head Road.
Alfred Chandler, Post Office-street.

Honorary Members:—

In accordance with a recommendation from the Council, Professor L. G. De Koninck, M.D., of the University of Liege, and Sir James Cockle, M.A., F.R.S., Chief Justice of Queensland, were duly elected Honorary Members of the Society.

The certificates of two new candidates were read.

Donations were laid upon the table. The Chairman announced that the Council intended to make arrangements next year to open the office as a Reading Room on three nights a week, in addition to Wednesday afternoon as at present.

SOCIAL AND SANITARY SECTION.

PROFESSOR LIVERSIDGE read a letter from the Social and Sanitary Section of the Society, requesting the co-operation of the Society with the Agricultural Society for the exhibition of articles tending to promote sanitary science, and to improve sanitary appliances.

Moved by Mr. H. C. RUSSELL, seconded by the Rev. WM. SCOTT, and carried,—That the above letter be referred to the Council of the Society.

PUBLIC HEALTH BILL.

A letter was read from the Colonial Secretary's Department, acknowledging the receipt of a letter from the Society requesting the appointment of a Parliamentary Draftsman to act with the Committee deputed by the Society to prepare a Public Health Bill, and stating that although what was set forth in the resolutions of the Society concerning a request of the Colonial Secretary was incorrect, the Premier (Mr. ROBERTSON) was not unwilling to arrange that the assistance of a Draftsman be given to the Society in the work it had in view, and he would accordingly make arrangements to that end.

Notice of Motion :—The Rev. WM. SCOTT gave notice that at the May meeting he should move,—"That in future no motion be made, of which notice has not been given at a previous meeting, excepting motions of adjournment or others of a formal character."

MR. CHARLES MOORE then read a paper by Mr. W. CHRISTIE, "On the Forest Vegetation of Central and Northern New England, in connection with Geological Influences."

The discussion on the Rev. W. B. CLARKE's paper entitled "Effects of Forest Vegetation on Climate," was resumed. The following gentlemen took part in the debate, viz. :—Mr. Charles Moore, Mr. Brodribb, Dr. Neild, Mr. Dixon, Rev. Wm. Scott, Mr. Russell, and the Chairman.

The CHAIRMAN brought before the notice of the meeting an American publication "On Forest Culture," intended to encourage the cultivation of the Eucalyptus in America.

The following papers were then read by Professor LIVERSIDGE, viz. :—

1. On Fossiliferous Silicious Deposit from the Richmond River, and
2. "On a remarkable specimen of contorted Slate."

The papers were illustrated by geological specimens.

Mr. Makin exhibited specimens of shale and coal from the Berrima District, and stated that he would read at some future meeting a paper "On the mineral productions of Berrima."

The meeting then adjourned until May.

ADDITIONS

TO THE

LIBRARY OF THE ROYAL SOCIETY OF NEW SOUTH WALES.

DONATIONS—1876.

The names of the Donors are in *Italics*.

REPORTS, OBSERVATIONS, &C.

ADELAIDE:—South Australian Institute, Annual Report, 1875–6.—*The Institute.*

ALBANY, N.Y.:—Manual for the use of the Legislature of the State of New York, 1871.

Civil List and Forms of the Colony and State of New York. Fifty-fifth, Fifty-sixth, and Fifty-seventh Annual Report of the Trustees of the New York State Library.

Twentieth, Twenty-first, Twenty-second, Twenty-third, Twenty-fourth, and Twenty-fifth Annual Report of the Regents of the University on the condition of the State Cabinet of Natural History; with Plates.

Report of the Regents of the University on the Boundaries of the State of New York.

Catalogue of the New York State Library, 1872.

Meteorology 1826–1850, and from 1850–1863. Second Series.—*The State Library, Albany, N.Y.*

BERLIN:—Königliche Akademie der Wissenschaften, Berlin. Monthly Reports, from 1860. 15 vols.—*The Academy.*

Nachrichten von der Gesellschaft der Wissenschaften, und der G. A. Universität, Göttingen, 1875.

Königliche Statistisch-topographische Bureau. Two Reports.—*The Bureau.*

BONN:—Verhandlungen Naturhistorischen Vereines der Preussischen Rheinlande und Westphalens.—*The Society.*

CALCUTTA:—Records of the Geological Survey of India. Vol. VIII, Part 1, 2, 3, and 4, 1875.

Records of the Geological Survey of India. Vol. IX. Part 1. 1876.

Memoirs of the Geological Survey of India. Vol. X.

Memoirs of the Geological Survey of India. Vol. XI.

Palæontologia Indica; being Figures and Descriptions of the organic Remains procured during the progress of the Geological Survey of India.

Palæontologia Indica. Vol. I. 4.

Jurassic Fauna of Kutch. Vol. 1, 2, Ser. IX. The Cephalopoda (Ammonitidæ). By Wm. Waagen, Ph. D. With Plates.

Do., do., do., Ser. IX. The Belemnitidæ and Nautilidæ.—*Thos. Oldham, LL.D., F.R.S., Superintendent of the Geological Survey of India.*

CAMBRIDGE, U.S.A.:—Annual Report of the Trustees of the Museum of Comparative Zoology at Harvard College, in Cambridge, together with the Report of the Committee on the Museum for 1873.—*The Trustees.*

CARLSRUHE:—Verhandlungen des Naturwissenschaftlichen Vereins in Karlsruhe, 1864 and 1866, 1869, 1871, 1873, and 1876.—*The Society.*

DRESDEN:—General Directorship of Royal Collection for Arts and Science, Dresden—

1. Die Urnenfelder von Strahlen.
2. Geologie von Sumatra.
3. Der Arabische Himmelsglobus.
4. Mittheilungen aus dem Königl. Geologischen Museum.
5. Mittheilungen uber die Sammlungen des Königl. Mathem-Physikal. Salons.
6. Katalog des Sammlungen des Königl. Mathem.-Physikalischen. Salons.

—*The Institution.*

FRANKFURT A M.:—Bericht uber die Senckenbergische Naturforschende Gesellschaft, 1874–75.—*The Society.*

FREIBURG: Berichte der Naturforschenden Gesellschaft. Freiburg, 1870–71–72–73.—*The Society.*

GLASGOW:—The Glasgow University Calendar for the Year 1876–77.—*The University.*

GORLITZ:—Abhandlungen der Naturforschenden Gesellschaft in Gorlitz, 1857, 1860, 1862, 1868, 1871, and 1875.—*The Society.*

HAMBURG:—Geographische Gesellschaft. (Two Reports.)—*The Society.*

HEIDELBERG:—Verhandlungen des Naturhistorisch-Medicinischen Vereins zu Heidelberg. Neue Folge 1, 2, 3.—*The Society.*

HOBART TOWN, Tasmania:—Results of Five Years' Meteorological Obserretions for Hobart Town. By Francis Abbott, F.R.A.S.—*The Author.*

Monthly Notices, Royal Society of Tasmania, 1874.—*The Society.*

JENA:—Report from the Society of Natural History in Jena, 1874, 1875, and 1876.—*The Society.*

LONDON:—Proceedings of the Royal Society. Vol. XXIV., Nos. 164, 165, 166, 167, 168, 169.

Ditto. Vols. XXV and XXVI.—*The Society.*

MELBOURNE:—Results of Observations in Meteorology, Terrestrial Magnetism, as taken at the Melbourne Observatory during the year 1874, vol. III., under the direction of Robert L. J. Ellery, Government Astronomer.—*The Observatory.*

Victoria Patents and Patentees. Vol. VIII.—*The Registrar General of Victoria.*

Reports of the Proceedings of the Central Board of Health, Melbourne.—*The Central Board of Health.*

Report of the Chief Inspector of Mines to the Hon. the Minister for Mines, for the year 1875.

Reports of the Mining Surveyors and Registrars, quarter ending 30th June, 1876, Victoria.

—*The Department of Mines.*

Abstracts of Specifications of Patents applied for from 1854 to 1866.—*The Registrar General's Office, Melbourne.*

Geological Sketch Map of Victoria; Geological Sketch Map of the Cape Otway District; Geological Sketch Map of a part of the Mitchell District; Division of the Gippsland Mining District.

MELBOURNE—*continued.*

Geological Map of Ballaarat Gold Field, with Notes and Section.
Do. of Sandhurst.
Do. of Beechworth.
Map showing the Distribution of Forest Trees in Victoria.
Geological Survey of Victoria; Reports of Progress, Nos. I., II., and III.
Prodromus of the Palæontology of Victoria. Decades I, II, and III.
Observations on New Vegetable Fossils of the Auriferous Drifts of Victoria.
Reports of the Chief Inspector of Mines for the years 1874–75.
Mineral Surveyors' and Registrars' Reports for the quarter ending 31st March, 1876.
—*The Hon. the Minister of Mines, on behalf of the Government of Victoria.*
The Statistical Register of the Colony of Victoria for the year 1874. Part VIII—Vital Statistics. Part IX—Religious, Moral, and Intellectual Progress. (Two copies.)
Statistics of Friendly Societies for the year 1874.
Statistical Register of the Colony of Victoria, 1874; General Index; The Government Statist of Victoria; Australian Statistics, 1874; Supplementary Tables.
Agricultural Statistics, 1875–76. (Two copies.)
Statistical Register of Victoria. Parts 1, 2, and 3.
—*The Government Statist of Victoria.*
Mineral Statistics of Victoria for the year 1875. (Two copies.)
Mineral Statistics of Victoria for the year 1875.
—*The Minister for Mines, on behalf of the Government of Victoria.*
Statistical Register of the Colony of Victoria for the year 1875—Part IV—Interchange; Part V—Production; Part VI—Law, Crime, &c.; Part VII—Accumulation. Australian Statistics for the year 1875.—*The Government Statist.*

MOSCOW:—Bulletin de la Société Imperiale des Naturalistes de Moscow. Parts 1 and 2. 1869.

OTAGO, New Zealand:—Report on the Geology and Gold Fields of Otago, by F. W. Hutton, F.G.S., C.M.Z.S., Provincial Geologist, and G. H. F. Ulrich, F.G.S.—*The Provincial Geologist.*

PARIS:—Bulletin de la Société Géologique de France. Troisième Série, tome premier.—*The Society.*
Annuaire de la Sociéte Philotechnique, Année 1875, tome trente-sixième.—*The Society.*

PISA:—Atti della Societa Toscana di Scienze Naturali Ressidente in Pisa. Vol. I, Parts 1 and 2.; Vol. II, Part 1.—*The Society.*

STOCKHOLM:—Meteorologiska Jakttagelser i Sverige. 1873.
Ofversigt af Kongl. Svenska Vetenskaps—Akademiens Förhandlingar. 28 to 31.
Handlingar (Mémoires). 4: 0, Bd. 9. Parts 2, 10 & 12.
Bihang (Supplement aux Mémoires). In 8: 0, H. 1: 1 & 2. 2: 1 & 2.
Lefuadsteckingar. Bd. 1: 3.
Handlingar (Mémoires), in 4to., bd. 11, with 53 Plates (Echinoidees).
Bihang (Supplement aux Mémoires). Bd. 3: 1.
Ofversigt (Bulletin), in 8vo., 1875.
Eugenies Resa Omkring Jorden, 1851–1853. Nos. 13 and 14.—*L'Académie Royale Suédoise de Stockholm.*

SYDNEY :—Progress Reports of the Sydney **Sewage and Health Board**. Parts 1 to 11.

Report on Sydney and Suburban Water Supply. 1 and 2.

An Act for preventing Nuisances, 39 Vic. 14.

Do. do. do. No. 7.

Professor Pell, Chairman of the Sewage and Health Board.

The Blue Book, 1875.—*The Government Printer.*

Annual Report of the Department of Mines, New South Wales, for the year 1875.—*The Hon. the Minister for Mines.*

Government Observatory—Report of Astronomer, 1874-75.—*The Observatory.*

Results of Meteorological Observations made in New South Wales during 1874.—*The Observatory.*

Proceedings of the Linnean Society of New South Wales. Vol. 1, Part 1, and Part 2; with Plates.—*The Society.*

WASHINGTON :—Meteorological Observations durnig the year 1872, in Utah, Idaho, and Montana.—*The Smithsonian Institution.*

Daily Bulletin of Weather Reports for the Month of March, 1873.—*Office of the Chief Signal Officer.*

Reports of Observations of the Total Eclipse of the Sun; with Plates.

Determination of the Astronomical Latitude of a Station by means of the Zenith Telescope.

Determination of the Astronomical Azimuth of a Direction.

Report on the Results from the Observations made at the Magnetical Observatory on Capitol Hill.

The Star Factors—A.B.C., for reducing Transit Observations, 1874.

On the use of the Zenith Telescope for Observations of Time.

Notes on Measurements of Terrestrial Magnetism.

United States Coast Survey Catalogue of Charts, 1875.

Report of the Superintendent of the United States Coast Survey for 1871.

United States Coast Survey Report, 1868. Appendix, No. 10.

Do. do. do. 1869. Appendix, 13.

Do. do. do. 1870. Appendix, 11, 12, 13, 16 19, and 21.

Do. do. do. 1871. Appendix, 8, 9, 11, 15, 16, and 17.

Do. do. do. 1872. Appendix, 12.

Do. do. do. 1873. Appendix, 12, 13, 14, and 22.

On the use of Railways for Geodetic Surveys.

Special Survey of the Harbour of Province Town, in the State of Massachusetts.

Report on the Tides and Currents of Hell Gate, one of the entrances to New York Harbour.

Scientific Lecture on Tides and Tidal Action in Harbours.

Field Catalogue of 983 Transit Stars.

United States Coast Survey Projection Tables.

Report on Mt. St. Elias.

A Treatise on the Plane Table, and its use in Topographical Surveying.

On the Reclamation of Tide Sands and its relation to Navigation.

Memoranda relating to the Field Work of the Secondary Triangulation.

Reports concerning Martha's Vineyard and Nantucket.

Cape Cod Ship Canal Report.

WASHINGTON—*continued.*

On the Air contained in Sea Water.
—*The United States Coast Survey Office.*

Coasts and Islands of the Mediterranean Sea, Part I.—*The Bureau of Navigation.*

Coasts and Ports of the Bay of Biscay, No. 60. Hydrographic Office, U.S. Navy.—*The Bureau of Navigation.*

Annual Report of the Board of Regents of the Smithsonian Institution for the year 1873.

Daily Bulletin of the Signal Service, U.S. of America, January and February, 1873.

Report of the U.S. Geological Survey of the Territories, Vol. VI. Cretaceous Flora; with Plates.

Catalogue of the Publications of the United States Geological Survey of the Territories, by F. V. Hayden, Geologist-in-charge, 1874.

Chronological Observations on Introduced Animals and Plants, Part 1.

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Bulletin of the United States Geological Survey of the Territories, No. 2.

Synopsis of the Flora of Colorado, by Chas. C. Porter and John M. Coulter.
—*The Smithsonian Institution.*

Professional Papers, Corps of Engineers:—
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No. 12. Tables and Formulæ—Lee.
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Invertebrate Fossils, 1871–2–3.

Systematic Catalogue of Vertebrate of the Eocene of New Mexico, 1874.

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—*The Office of the Chief of Engineers.*

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Annual Report of the Board of Regents of the Smithsonian Institution for the year 1874.

—*The Smithsonian Institution.*

Reports of the Department of Agriculture for 1872–73–74.

Monthly Reports of the Department of Agriculture for 1872–73–74.

—*The Department.*

Report of the Smithsonian Institution, 1874.

Report of Explorations in 1873 of the Colorado of the West and its Tributaries. (Two copies.)

Memoirs of the American Association for the advancement of Science. Vol. I.

Revision of the hitherto known Species of the genus Chionobas in North America, by Saml. H. Scudder.

Entomological Notes by S. H. Scudder, 1, 2, 3, and 4.

Annual Report of the Trustees of the Museum of Comparative Zoology, 1874.

Thoughts on the nature and origin of Force, by W. B. Taylor.

Distribution of Insects in New Hampshire.

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The Structure and transformation of Enmæus Atala.

Memoirs of the Boston Society of Natural History. Vol. II, Part III, No. IV.

Notes on the Stridulation of some New England Orthoptera.

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Note sur l'Œuf et le Jeune Age de Chenille d'Œneis aello.

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WASHINGTON—*continued.* *Ute Country.*

Maps of Wheeler's Atlas (Explorations, west 100th Meridian).
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Do. Yellow Stone and Missouri Rivers, &c.
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Do. San Domingo.
Do. Florida.
—*The Office of the Chief of Engineers.*

WELLINGTON:—Tenth Annual Report of the Colonial Museum and Laboratory, together with a list of Donations and Deposits during 1874–75.—*The Colonial Museum.*

Transactions and Proceedings of the New Zealand Institute, 1875. Vol. VIII.—*The Institute.*

MISCELLANEOUS.

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List of Palæozoic Fishes. By W. J. Barkas.
On the Microscopical Structure of Fossil Teeth from the Northumberland True Coal Measures.—*Idem.*

BENSUSAN, L. S.
Proceedings of the Geological Society. Vols. 2 and 3.
Quarterly Journal of the Geological Society. 13 Nos.
Proceedings of the Royal Society, London. 40 Nos.

BLEASDALE, REV. DR.
An Essay on the Wines sent to the late Intercolonial Exibition, of the Colonies of Victoria, New South Wales, and South Australia.
Philadelphia Centennial Exhibition of 1876. (Melbourne, 1875.) Official Record.

BRAZIER, JOHN, C.M.Z.S.
Description of eleven new species of Terrestrial and Marine Shells from North-east Australia. By J. Brazier, C.M.Z.S.
Description of ten new species of Shells from the collection of Mr. Chas. Dixon of Brisbane, Queensland.—*Idem.*

DIXON, W. A., F.C.S.
C. Plinny Historiæ Mundi.
Tables of Quantitative Analysis, arranged for the use of Students, By W. A. Dixon, F.C.S.

Dr. P. L. HATCH, United States:—Constitution and By-laws of Minnesota Academy of Natural Sciences—1873.
Bulletin of the Minnesota Academy of Natural Sciences—1874.

LIVERSIDGE, PROFESSOR ARCHIBALD, F.C.S.
Statistical Register of New South Wales—1874.
Catalogue of the Minerals and Rocks in the collection of the Australian Museum, by Gerard Krefft, F.L.S.
Map of New South Wales (mounted and varnished).
Victorian Intercolonial Exhibition—1875, preparatory to the Philadelphia Exhibition—1876 Official Catalogue.
Official Catalogue of the natural and industrial Products of New South Wales, forwarded to the International Exhibition of 1876, Philadelphia.
Cave-hunting, by W. Boyd Dawkins.
Darwin's Naturalist's Voyage.
Nicol's Mineralogy.
Disease in the Sugar-cane, Queensland. By Professor Liversidge.

MACLAY M. VON (Batavia).
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Anthropologische Bemerkungen neber die Papuas der Maclay, Kuste in New Guinea.—*Idem.*
An Ethnological Excursion in Johore.—*Idem.*

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Fragmenta Phytographiæ Australiæ. Vol. 9. By Baron von Müller.
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Descriptive Notes on Papuan Plants. Parts I and II. By Baron von Müller.

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Photograph and Key of Scientific Celebrities (German).

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The Westfield Steamer Boiler Explosion.
Tensile Strength of American and English Iron and Steel.
A Paper relating to Traction Engines.
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SCIENTIFIC PERIODICALS SUBSCRIBED FOR.

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Encyclopædia Britannica—new edition—half-bound in Russia (5 vols.); as issued.
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Fresenius' Zeitschrift für Analytische Chemie.
Geological Magazine.
Geological Record.
Journal of the "Geological Society," London.
Journal of the "Geological Society," France.
Journal of the "Chemical Society," London.
Journal of the "Linnean Society," London.
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Journal of the "Royal Microscopical Society," London.
Nature.
Philosophical Magazine.
Proceedings of the "Geological Association," London.
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Publications of the "Palæontographical Society," London.
Publications of the "Royal Geological Society," Cornwall.
Quarterly Journal of the "Meteorological Society."

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ITALY.

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INDIA.

Calcutta.—The Geological Survey of India. Nos. 1, 2, 3, 4, and 5.

SCIENTIFIC INSTITUTIONS OF GERMANY.

Berlin.—Königliche Akademie der Wissenchaften. Transactions of the Royal Society of New South Wales. 1867–75, and Nos. 2, 3, 4, 5, and 6. (14 vols.)

Bonn.—Naturhistorische Verein der Pruessischen Rheinlande und Westphalens in Bonn. Transactions of Royal Society of New South Wales. 1868–75, and Nos. 2, 3, 4, 5, and 6. (13 vols.)

Carlsruhe.—Naturwissenschaftlicher Verein zu Carlsruhe. Nos. 1, 2, 3, 4, and 5.

Dresden.—General Direction der Königliche Sammlungen für Kunst and Wissenchaft zu Dresden. Transactions of the Royal Society of New South Wales. 1868–75, and Nos. 2, 3, 4, 5, and 6. (18 vols.)

„ Das Statistische Büreau des Ministeriums des Innern zu Dresden. Nos. 1, 2, 3, 4, 5, and 6.

„ Die Kaiserlich Leopoldinisch-Carolinisch Deutsche Akademie der Naturforscher zu Dresden. Nos. 1, 2, 3, 4, 5, and 6.

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„ Naturforchende Gesellschaft zu Freiberg. Nos. 1, 2, 3, 4, and 5.

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Stuttgart.—Königlich Statistich-Topographische Büreau zu Stuttgart. Nos. 1, 2, 3, 4, and 5.

Wurttemburg.—Der Verein für Vaterlandische Naturkunde in Wurttemburg. Transactions of Royal Society of New South Wales. 1867–75, and Nos. 2, 3, 4, 5, and 6. (14 vols.)

Russia.

St. Petersburg.—Académie Imperiale des Sciences. Nos. 1, 2, 3, 4, 5, and 6.

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SOUTH AUSTRALIA.

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" The South Australian Institute. No. 1.

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Papers and Periodicals.

American Journal of Science and Arts, New Haven, Conn. Nos. 1, 2, 3, 4, 5, and 6.
Argus, Melbourne, Victoria. No. 1.
Colonist, London. No. 1.
Evening News, Sydney. No. 1.
Geological Magazine, London. No. 1.
Geological Record, London. No. 1.
Nature, London. No. 1.
Quarterly Journal of Science. No. 1.
Sydney Morning Herald. No. 1.
Westminster Review, London. No. 1.

SUMMARY OF NUMBER OF PUBLICATIONS DISTRIBUTED BY THE SOCIETY IN THE YEAR 1876.

10 to Austria.
6 " Belgium.
10 " Canada.
161 " Great Britain and Ireland.
72 " France.
5 " Italy.
5 " India.
128 " Germany.
6 " Russia.
5 " Sweden.
16 " Switzerland.
96 " United States.
44 " Colonies.
15 " Periodicals and papers (for review).

Total—579

REPORTS FROM THE SECTIONS

(IN ABSTRACT).

REPORTS FROM THE SECTIONS.

(In Abstract.)

SECTION A.—ASTRONOMY AND PHYSICS.

PRELIMINARY MEETING—MONDAY, 19 JUNE, 1876.

In accordance with Rule XXIX of the Society's new Bye-laws, a meeting was held in the Society's rooms, on Monday, 19th June, 1876, to organize a Section for Astronomy, Meteorology, Physics, Mathematics, and Mechanics, the following gentlemen being present:—

Mr. H. C. Russell, F.R.A.S., in the Chair.

Mr. Bolding,	Mr. H. A. Lenehan,
Rev. W. B. Clarke, F.R.S., &c.,	Dr. Leibius,
Mr. J. U. C. Colyer,	Prof. A. Liversidge,
Mr. J. V. Dalgarno,	Mr. W. MacDonnell,
Hon. L. F. De Salis, M.L.C.,	Mr. W. J. MacDonnell, F.R.A.S.,
Mr. E. Du Faur, F.R.G.S.,	Mr. W. H. Maguire,
Mr. G. D. Hirst,	Rev. W. Scott, M.A.

Mr. Voss.

It was resolved that the Section be formed, and the following office-bearers were appointed for the current session:—Chairman, Mr. H. C. Russell, B.A., F.R.A.S., &c.; Hon. Secy., Mr. W. J. MacDonnell, F.R.A.S.; Committee, Mr. G. D. Hirst, Mr. H. A. Lenehan, Rev. W. Scott, M.A., and Mr. H. G. A. Wright, M.R.C.S.

The Chairman, after stating that Astronomy was likely to prove the chief object of attraction, drew the attention of the Section to the requisition made by the Royal Astronomical Society of London, for co-operation of southern astronomers in the work of observing the planet Jupiter during his present favorable opposition, and Mr. Russell recommended the Section to take up this work as far as possible.

Mr. Hirst gave some particulars of his observations on Jupiter, remarking the great difference in the colours of the equatorial belt as seen in different classes of telescope. In the Observatory *refractor* of 11½ inches aperture the colour of the belt was pink, and in Mr. Colyer's 10½-inch Browning *reflector* used by him, it was ochreish-yellow.

Hon. L. F. De Salis, M.L.C., referred to a periodicity apparent in the recurrence of meteorological phenomena in this Colony, and promised to return to the subject at greater length at next meeting of the Section. Mr. E. Du Faur, in supporting Mr. De Salis's view, instanced the remarkable changes that have been observed in Lake George, as an example of the periodicity theory advanced by Mr. De Salis. After further discussion the meeting terminated.

WEDNESDAY, 26 JULY, 1876.

Mr. H. C. Russell, F.R.A.S., in the Chair.

Hon. L. F. De Salis, M.L.C., read a paper on "Lunar Influence on the Weather and Periodicity of the Seasons." He stated that scientific investigation into the causes which control the weather was one of high practical utility to the Colony, and was well deserving of the Section's attention. Throughout recent scientific works there are several assertions that periodicity has been traced in important weather changes around the Mauritius, coincident with the periodic changes that take place in the sun. After suggesting that lunar influence was not a fable of olden times, and referring to Saxby's theories, which however were not generally accepted by the late Admiral Fitzroy and men of his calibre, Mr. De Salis remarked from his own observations during a colonial lifetime that our winds veered round in direction contrary to the cyclonic rule, during a period equalling in time a quarter lunation. Mr. De Salis referred to several instances where this rule was apparently confirmed. He also noticed that besides this monthly influence there was one traceable to the lunar cycle of 19 years or its half period of 9½ years when the moon's position was analogous to the changes at full and new in the ordinary lunation of 29 days. He pointed out that the floods on the Murrumbidgee in 1844, 1852–3, 1861–2, and 1870–1–2, were in strong confirmation of the existence of this period. A co-operation in the observation of Australian climatology was strongly urged, and the example of the United States expending £300,000 on Meteorology was quoted as being worthy of imitation. A proportionate sum for the united Australian Colonies would only amount to £20,000.

In the discussion which followed the reading of Mr. De Salis's paper,—

Mr. Russell said he had given the matter great attention; he formerly advocated the 19 year period, and had afterwards abandoned it; but recent facts in confirmation had so pressed themselves upon him that he felt compelled to adopt the theory once more.

After further discussion the meeting terminated.

Eleven members were present.

WEDNESDAY, 30 AUGUST, 1876.

Mr. H. C. Russell, F.R.A.S., in the Chair.

In answer to a question made by one of the members present, Mr. Russell described some of the methods adopted in the manufacture of optical glass as noticed by him in his recent visit to Europe and America. He also explained the beautifully delicate apparatus invented by the Hamburgh optician, Mr. H. Schrœder, for testing the curves of telescope lenses with an accuracy previously unknown.

The Chairman then read some notes he had prepared on the planet Venus. The white patch visible during the transit of December, 1874, was again detected on 15th June, 1876. On several occasions part of the disc was visible in the telescope; the dark portion being apparently projected upon a lighter back ground of sky. On 30th June, Mr. Russell, in observing Jupiter's satellites with a power of 800, noticed that the third satellite was of a ruddy colour and sharply defined disc. A mean of 46 micrometrical measure gave a polar flattening to Jupiter of 1–17·5.

WEDNESDAY, 27 SEPTEMBER, 1876.

Mr. H. C. Russell, F.R.A.S., in the Chair.

Mr. G. D. Hirst exhibited a drawing of Saturn executed from a 10¼-inch silvered glass equatorial with a power of 214. He remarked the square-shouldered appearance of the ball of the planet noticed by former observers. The most remarkable feature on the ball was a dark belt near the equator of a rich brown inclining to red; the black line in the centre of this belt, first noticed by Mr. Russell a couple of years ago, was not visible in the reflector. The poles of the planet exhibited a beautiful bluish-grey, shading off into a yellow towards the equator. Ball's division in the ring was only visible at the two extremities. The crape ring appears as a remarkably dark band crossing the disc of the planet.

Mr. Russell stated that the narrow black line indicating the shadow of the ring on the ball appeared a short time ago perfectly straight instead of following the outline of the ring; a micrometer laid along it showed no deviation.

A discussion followed relative to the gale of 10th September, as compared with tropical tornadoes, Mr. Du Faur remarking that from his experience within the tropics the velocity of the wind in the late gale, although very high, must have fallen far short of what it attained during West Indian hurricanes. The discussion then turned to some of the meteorological characteristics of this Colony. Messrs. De Salis and Du Faur gave some particulars of important changes produced in the configuration of the country by floods in the interior.

The meeting then closed.

WEDNESDAY, 25 OCTOBER, 1876.

Mr. H. C. Russell, F.R.A.S., in the Chair.

Mr. Colyer read a letter from Mr. J. Browning, the well-known London optician, relative to the variation in the colour of the equatorial belts of the planet Jupiter when observed through refracting or reflecting telescopes. The question as to which class of instruments gave the most correct results was a difficult one to decide; the Chairman wished that those members in possession of adequate means should take the matter in hand, so that if any law of variation exists it might be brought to light.

Mr. Du Faur informed the Chairman that he had been in correspondence with some gentlemen in the far interior who were willing to take meteorological observations if instruments for that purpose were supplied to them. Mr. Russell said he had also been taking steps in the same direction, so that regular observations of the climatology of the interior could be taken.

Mr. Russell then read a long paper from Mr. Jones, of Tamworth, on an extraordinary dry fog observed in the neighbourhood of Tamworth, on the morning of 12th October. Mr. De Salis had noticed a somewhat similar phenomenon in 1851, which was ascribed to the prevalence of extensive bush fires then raging in Victoria, but whether the Tamworth dry fog could be traced to a similar origin required further evidence before it could be decided.

WEDNESDAY, 29 NOVEMBER, 1876.

Mr. H. C. Russell, F.R.A.S., in the Chair.

Rev. Geo. Martin read a long and interesting paper on the performance of his "Cooke" telescope of 5 inches clear aperture, 6 feet 3 inches focal length. He succeeded in resolving the globular cluster ω. Centauri, with the exception of the central condensation, also the clusters 47 Toucani and 13 M. Herculis. In the resolution of these objects, Mr. Martin found that the light-grasping power of his instrument approached very nearly to its theoretical value. For definition he had tried the capacity of his object glass on Antares, Nu (ν) Scorpii, η Orionis, γ Centauri, all of which difficult doubles he succeeded well in resolving. After referring to other work performed by his telescope, Mr. Martin spoke of the example of Mr. Burnham, of Chicago, in reaping a harvest in fields where Herschel, Struve, and other eminent observers had been working, and he stated that our southern heavens present a splendid field for investigation for any competent observer armed with moderate means and a little patience, in which he would meet with a rich and ample reward.

A short discussion ensued on Mr. Martin's paper.

SECTION B.—CHEMISTRY, MINERALOGY, and by amalgamation with SECTION C., GEOLOGY and PALÆONTOLOGY.

PRELIMINARY MEETING—20 JUNE, 1876.

THE preliminary meeting of this Section was held on 20th June, 1876, when PROF. LIVERSIDGE was appointed Chairman of the Section, W. A. DIXON Hon. Secretary, and Messrs. BENSUSAN, M'CUTCHEON, SLEEP, and TULLOH a Committee; and the meeting night for the Section was fixed for the second Wednesday of each month.

WEDNESDAY, 12 JULY, 1876.

PROFESSOR LIVERSIDGE in the Chair.

The proposal to temporarily amalgamate Section C. with this Committee was agreed to at this meeting.

Mr. DIXON read a note on some analysis of mud from George and Pitt Streets, showing that the amount of organic matter varied from 18 to 55 per cent. of the dried mud, and that the proportion of inorganic matter (*i.e.* abraded stone and iron) to organic matter rose in proportion to the wetness of the streets. He said that although little reliance could be placed on results obtained from three or four analyses, the numbers he had obtained showed that, taking 100 parts of organic matter (horse-dung) to represent a certain amount of traffic, 407 parts of stone were ground up when the streets were kept copiously watered, whilst 66 parts only of stone were pulverized by that traffic when the streets were only slightly sprinkled with water. The results approximated to those obtained by Dr. Letheby from London street mud, which showed that wet weather largely increased the quantity of abraded stone and wear of the streets.

Mr. BENSUSAN introduced to the notice of the meeting the new work on Pyrology, by Major Ross, containing new methods of blowpipe analysis. The Chairman exhibited a case containing specimens of the rare metal, Thallium, and a number of its salts.

WEDNESDAY, 9 AUGUST, 1876.

PROFESSOR LIVERSIDGE in the Chair.

Mr. BENSUSAN exhibited a specimen of the new alloy, composed of copper 88 per cent., tin 10 per cent., and manganese 2 per cent., proposed to be used for armour-plating and other purposes. The specimen he had himself prepared, and he explained that its peculiar excellence consisted in its superior toughness, and to the fact that a shot punched a hole in the plates without rending them.

An interesting conversational discussion upon *Chemical* matters was maintained for some time.

WEDNESDAY, 13 SEPTEMBER, 1876.

Mr. M'Cutcheon in the Chair.

Mr. Bensusan exhibited specimens of native bismuth from New England; a mineral from near Rockhampton containing gold, nickel, and copper; an earthy mineral containing cobalt; elaterite from near Nattai; also carbonate and native copper. He also read his paper on recent copper-extracting processes, which was afterwards read before the Society.

WEDNESDAY, 8 NOVEMBER, 1876.

Professor Liversidge in the Chair.

Mr. Sleep exhibited specimens of *Ancyloceras gigas* and *Scaphites*, from the Flinders River, Queensland.

Professor Liversidge laid on the table specimens of tin ore in a "cement" matrix sent to him by Mr. Cadell, from Vegetable Creek, New England, accompanied by a letter, in which Mr. Cadell said, "I think the difference between 'black' and 'ruby' tin ore can now be accounted for, the discovery having been made accidentally on our claim. You are aware that all our *deep lead* carries black tin, the surface claims only producing 'ruby.' Over some portions of our deposit (deep lead) we have found quantities of ore cemented into one compact mass by oxide of iron. This Mr. O'Daly tried to reduce by burning, and while hot throwing cold water over the heap thus burnt. A large quantity became in this way pulverized, but the process changes the 'black' into 'ruby' tin. I send you specimens showing the cemented deposit before and after being calcined." The Chairman (Prof. Liversidge) pointed out that there were many essential differences between the more or less transparent native "ruby" tin and the brick-coloured calcined mineral. The members present, after examining the specimens, came to the conclusion that the red colour produced was not a conversion of "black" into true "ruby" tin, but merely the change of the ferrous oxide present into anhydrous ferric oxide.

Mr. Dixon laid on the table a specimen of a white earthy mineral sent to him by Mr. Chambers, of Maitland, who informed him that it occurred in a large bed on the side of a deep gully near the head of the Manilla River, New South Wales, and that in it a small cave had been excavated, partly by the action of the weather, partly by kangaroos, wallaroos, and wallabies, who were continually licking it. On these animals the mineral evidently excited a purgative action. This action, Mr. Dixon considers,

must be mechanical, as the mineral contains no constituent soluble in water. It yielded him the following results by analysis:—

Water	10·64	....	10·64
Ferric Oxide	2·92	Soluble in acid	13·87
Alumina	9·76		
Lime	·67		
Magnesia	·52		
Alumina	6·36	Insoluble in acid	75·76
Lime	1·38		
Silica	68·02		
	100·27		100·27

Hardness 1.—Specific gravity of powder 2·1, of mass dry about 1. It is infusible before the blowpipe, but contracts greatly by heat; adheres slightly to the tongue, and is devoid of plasticity.

PROFESSOR LIVERSIDGE mentioned that specimens of a very similar mineral had been sent to him as meerschaum from the Richmond and Clarence Rivers.

SECTION C.—GEOLOGY AND PALÆONTOLOGY.

AT the preliminary meeting of this Section, it was resolved to amalgamate it for the present with the Chemical Section.

SECTION D.—ZOOLOGY AND BOTANY, INCLUDING ENTOMOLOGY.

No meetings of this Section were held.

SECTION E.—MICROSCOPICAL SCIENCE.

PRELIMINARY MEETING—23 JUNE, 1876.

THE first meeting of this Section was held on the 23rd June, 1876.

PROFESSOR LIVERSIDGE, as General Secretary, opened the proceedings by drawing attention to the circular summoning the meeting. The election of officers was then proceeded with, with the following results:—Alfred Roberts, M.R.C.S., Chairman. Committee: Mr. Wm. MacDonnell, Mr. H. Paterson, Dr. Milford, Dr. Belgrave. Secretary, Mr. G. D. Hirst.

It was resolved that the Council should be applied to for a specimen cabinet for the reception of microscopic slides.

It was decided that the future meetings of this Section should be held on the third Wednesday in each month.

WEDNESDAY, 19 JULY, 1876.

ALFRED ROBERTS, M.R.C.S., in the Chair.

After arrangements had been made as to the future conduct of business brought before the Section, the Chairman presented a collection of slides of diatoms, mounted and named by Dr. Smith of Edinburgh.

Mr. ROBERTS then exhibited a very convenient arrangement for mounting with despatch and freedom from air-bubbles objects in Canada balsam. It consists of a tin stand constructed to hold water, which is kept hot by a spirit lamp underneath, the balsam contained in a small glass tube being retained in a fluid state by the steam which is confined in an outer chamber. The top of the stand forms a table on which the slides are laid during the operation of mounting, and by which they are kept warm as long as is desired. Mr. Wm. MacDonnell exhibited a large microscope by Powell and Lealand, with a quantity of accessory apparatus. This instrument was lent for the occasion by Mr. Cathcart of Newtown. Mr. H. Paterson exhibited an injection of the dentinal pulp of a kitten. This slide possessed special interest, having been prepared by the late Professor Queckett. Mr. George Hirst, a slide showing the formation at a very early date of striated muscular fibre in the human embryo. Dr. Milford, some scolices of Eccinococcus from the human subject. Some German objectives, on the immersion principle, by Siebert, were also exhibited by Mr. MacDonnell. These lenses possess remarkable defining and penetrating power, and work through considerable thickness of covering glass.

WEDNESDAY, 16 AUGUST, 1876.

ALFRED ROBERTS, M.R.C.S., in the Chair.

There was a good attendance of members. The Secretary reported that, in response to the request of the Committee, the Council of the Society had sent to London for a substantial microscope stand and necessary addenda for the use of this and the other sections.

Mr. H. PATERSON presented a slide containing a section of the dentinal tubes and enamel of the adult human tooth.

Mr. G. D. HIRST read a paper on the action of alkali on wool fibres.

Dr. MILFORD read a paper on the starch of the *Macrozamia spiralis*.

The following objects were exhibited:—By Mr. ALFRED ROBERTS, duodena of toad and black snake injected, and ova of frog; Mr. H. PATERSON, sections of teeth; Mr. TOOHEY, *Torula* or yeast plant; Mr. WM. MACDONNELL, scales of *Morpho menalaus*.

WEDNESDAY, 20 SEPTEMBER, 1876.

ALFRED ROBERTS, M.R.C.S., in the Chair.

The CHAIRMAN presented several well-mounted slides of foraminifera, mounted by Möller of Hamburgh.

Mr. W. MACDONNELL presented a series of twelve slides of foraminifera procured from soundings in different parts of the globe.

Mr. HUGH PATERSON presented a slide showing a case of exostosis of the human tooth, and accompanied his gift with some remarks on the nature of this disease.

Mr. G. D. HIRST presented a slide of a species of polyzoa common in Port Jackson; also a slide containing a section of schirrhus cancer mounted in glycerine.

Mr. E. WOODGATE presented a slide of crystals of salicine; also a section of pith of elder.

The CHAIRMAN presented a number of papers by Mr. Greville on new diatoms.

Mr. G. D. HIRST read a note on a species of chelifer found near Sydney, and common in dry wood and old lumber rooms, or in out-houses near scrub.

The CHAIRMAN exhibited specimens of the fangs of the death-adder and cobra, and explained their structure.

Mr. W. MACDONNELL exhibited a series of slides illustrative of human anatomy, and showing great skill in their preparation; Mr. H. PATERSON, sections of human bone; Dr. MILFORD, specimens of different types of cancer; Rev. GEO. MARTIN, a series of well-prepared slides in dammar varnish, sections of wood fibre mixed with coal from below a coal seam at Newcastle, foraminifera, also antennæ and palpi of tarantula.

Resolved:—That the subject for the next meeting should be diatoms in reference to their power as test objects.

WEDNESDAY, 18 OCTOBER, 1876.

ALFRED ROBERTS, M.R.C.S., in the Chair.

Resolved that the following proposal be submitted to the Committee of the Section:—That the Secretary be instructed to communicate with the *London Monthly Microscopical Journal*, with a report of the formation of the Section; and stating that, in the event of the proprietors being willing, monthly reports of the meetings would be forwarded to them for publication.

Mr. G. D. HIRST exhibited a rare and curious old publication, lent for the occasion, being a series of copper plates of microscropic objects, published by the celebrated Dr. Hooke 210 years ago, and entitled "*Micrographia.*". He drew attention to the excellence of these plates, which are the more remarkable when there are taken into consideration the rude and inefficient optical instruments at the disposal of microscopists at that early date.

The CHAIRMAN made some remarks upon the work, and stated that much had been done of infinite value to science by earnest observers using what would appear to us with our modern advantages totally inadequate instruments; and he wished, while speaking on the subject, to pay a tribute of respect to the memory of the late Mr. Wm. Sharp M'Leay, who, with only a simple dissecting miscroscope, rendered vast service to microscopic science by his researches, more particularly in those relating to the minute anatomy of insects.

Mr. WM. MACDONNELL exhibited a new hand magnifier by Browning, and called by him the Platyscopic lens. This is a triple achromatic combination, in which the spherical and chromatic aberrations were corrected by a central lens of dense glass. It is remarkable for its large and flat field and excellent definition.

A competitive trial of objectives of ⅛ in. focus took place, and a committee was appointed to report upon the merits of the glasses. The following makers were represented:—Messrs. Ross, Powell and Lealand, Smith and Beck, Crouch, Swift, Pillisher, and Gundlach. After careful examination, it was unanimously decided that Swift bore the palm for excellence of definition and resolving power, Ross and Powell and Lealand following very closely.

The Rev. GEO. MARTIN exhibited some very beautiful forms of discoidal diatoms, and some specimens of diatoms from Port Jackson were exhibited by the Chairman.

THURSDAY, 24 NOVEMBER, 1876.

ALFRED ROBERTS, M.R.C.S., in the Chair.

This meeting was postponed from the 15th inst.

A paper was read by Mr. J. U. C. COLYER on two species of insectivorous plants, *Drosera binata* and *Drosea spathulata*, indigenous to the Colony, and found in marshy ground near Sydney. The paper was accompanied by specimens of the plants in their natural state, and also by slides showing their microscopical structure.

Mr. G. D. HIRST made some remarks upon the paper read by Mr. Colyer, and exhibited some coloured drawings of the *Drosera binata* illustrative of the anatomy of the tentacles; these drawings he presented to the Section.

The CHAIRMAN stated that he hoped Mr. Colyer would make the paper delivered only the first of a series on the subject. Mr. Colyer undertook to prosecute the matter further and place the results before the Section.

The SECRETARY read a paper received by him from Mr. H. J. Brown, of Newcastle, on the milky juice of the climbing fig. The paper was accompanied by a specimen slide forming a good polariscopic object. He also, on behalf of Mr. Brown, presented to the Society's Cabinet several slides, being chiefly spiculæ of marine animals found on the coast near Newcastle.

THE MACROZAMIA SPIRALIS.

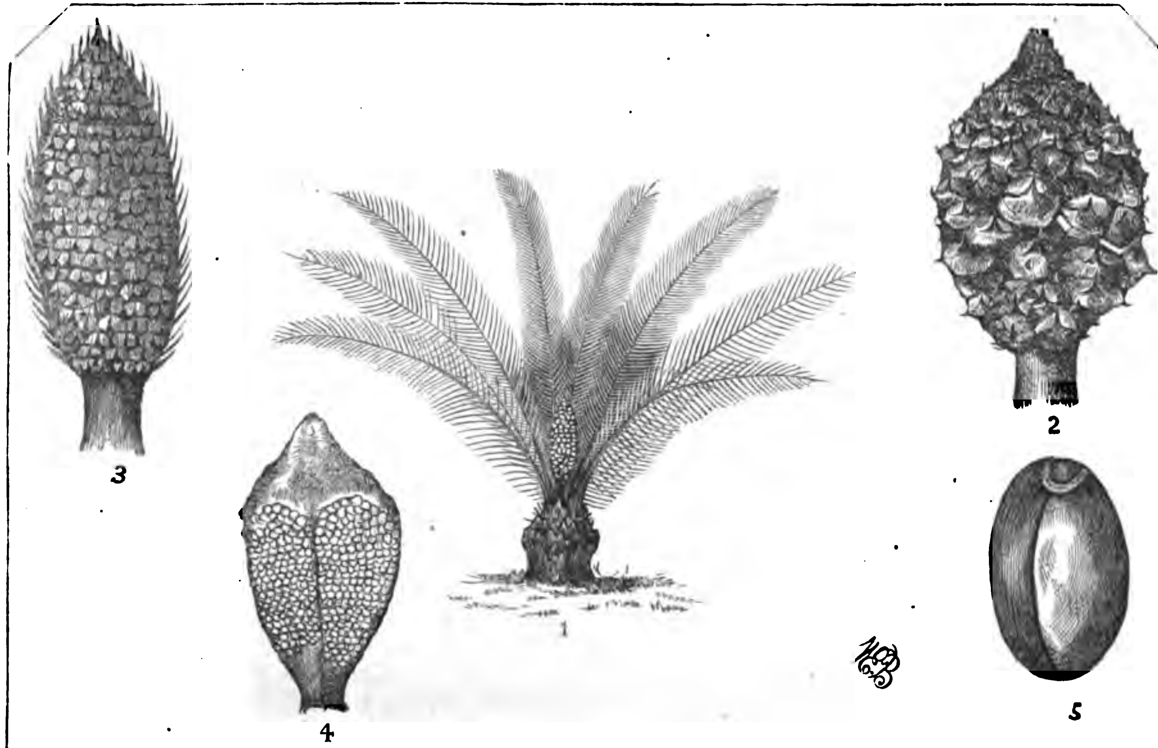
By F. Milford, M.D., M.R.C.S., &c.

[*Read before the Microscopical Section of the Royal Society of N.S.W., 6 August*, 1876.]

In the first number of the second volume of the New South Wales *Medical Gazette* is a paper on the *Macrozamia spiralis*, from the pen of Dr. G. Bennett, F.L.S. F.G.S., &c., &c. It was called forth by the fact that a child was taken seriously ill after partaking of the uncooked and unprepared nuts. Mr. W. C. Brown, M.L.A., wrote to Dr. Bennett on the subject, who in consequence indited the paper referred to, from which I cull a portion of the following brief notice:—"The *Macrozamia*, of the order *Cycadaceæ* or *Cycads*, are trees or shrubs having the appearance of palms and in some particulars of ferns. The flowers are diœcious (the male and female flowers being on separate plants). Both the male and female flowers are borne in cones composed of woody scales with a truncated six-sided summit, and the male flowers are arranged in tesselated catkins, the scales peltate; fruit, two at the under side of each scale. The stem beneath the surface of the earth and at a slight elevation above is in shape conical, but when it attains a greater elevation, which in New South Wales it does to the height of six or eight feet, it becomes cylindrical. The cone is about the size of a man's head, and composed of drupes about the size of a chestnut. Abundant fossil remains show that the plant formerly composed a large portion of the foliage of the British Isles." The plant is abundant about Sydney, and numbers may be seen near Bondi at present. If any one should have the desire of viewing the plant in its native habitat, he may do so at the foot of the hill near Bondi on the Old South Head Road. He should turn to the right down a track that leads to Bondi beach, and there numerous plants may be seen occupying an area of about two acres on the bank of a watercourse about one hundred yards from the main road. The plants usually occupy a limited space in the way thus indicated, and are found in sandy or rocky soil. The fronds of the plant have a very elegant appearance, resembling palms, and are used in Catholic Churches on Palm Sunday and for other decorative purposes in New South Wales. I remember when a youth of thirteen or fourteen years old procuring some of the nuts and taking them home for the purpose of eating them. I had not been long in the Colony at that time and had a distinct recollection of the flavour of English chestnuts, which these nuts so much resemble, so that I anticipated a great treat in eating them. I had three; one I

ate myself uncooked, and two I gave to my French governess. The effect upon me I shall not readily forget; it was as if I were suffering from a severe attack of sea sickness, accompanied by diarrhœa and cramps in the abdomen. However, I was perfectly recovered next day; not so, however, with the French lady, who was of rather a bilious temperament, and partaking of more of the nut than I did, she was laid up in bed for the space of a week, but eventually recovered under medical treatment. Before the colonisation of this country, the aborigines made use of the nuts; and the starch procured from the nuts and the roots was one of the chief supplies of their farinaceous food; but in order to get rid of the deleterious qualities of the contents of the nut, they were exposed to a constant stream of water on a sheet of bark for some days, and afterwards thoroughly roasted. Being desirous of ascertaining the nature of the poisonous material contained in the nut and tuber, I requested Mr. Norrie, chemist, of William-street, some time ago to make an analysis, and report upon it. He wrote to me afterwards as follows:—"I have the pleasure now to give you some account of my examination of the nuts of the *Macrozamia spiralis*. In the first place, the seeds were perfectly dry. On removing the shell and epidermis and pulping the seed, I obtained a large quantity of starch and gluten; testing the soluble portion, it was found to have a decided acid re-action; lime-water throws down oxalic acid in the shape of oxalate of lime; continuing my investigations further, I find a potash salt and isolate binoxalate of potash, which is the poisonous substance contained in these nuts. There is also every appearance of an alkaloid crystallizing in prisms, but the quantity operated on was so small that I could only get a microscopic specimen, it therefore requires further examination upon a larger quantity of material to test its particular properties. These seeds contain also vegetable albumen, gum, and sugar; and consequently as an article of food, as used by the blacks, they are of no mean value; for it must be remembered that in the roasting of these nuts, the binoxalate of potash would be converted at a low red heat into carbonate, modifying or completely destroying the poisonous properties."

Mr. Henry Moss, of Shoalhaven, has been for some time past engaged in manufacturing an edible starch from the nuts and tuber of the *Macrozamia*. The means he uses are these: he has the shells broken away from the nuts, then placed in tubs of cold water, and pounded quite soft with a wooden rammer, then roughly strained to get all the debris away, than strained through fine cloth and the liquid allowed to stand for forty-eight hours in a long cask; spill holes are made in the cask, a few inches from the bottom, so that the water can be drawn off without disturbing the sediment. After draining and adding fresh water, the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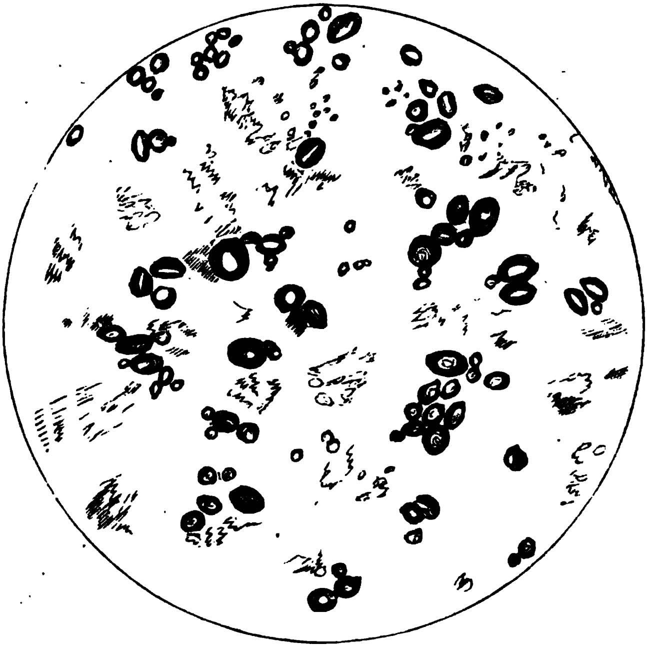

starch forms a cake at the bottom, the water is then all drawn off, the cake of starch cut out, and dried in the sun, and afterwards rolled. He calls the starch arrowroot, and says it is "as fine as any commercial arrowroot." He states that an infant child in the Shoalhaven district was reared upon it and nothing else. He sent me some pounds of it, and I gave samples to many of my friends. I also had some prepared for myself for breakfast, in spite of my previous unpleasant experience of it, and I was much pleased with its flavour, and as an article of diet I can recommend it to those who prefer light and nutritious food to beefsteaks and porter. I consider Mr. Henry Moss deserves the thanks of the community for thus inaugurating a valuable article of food, and I consider that they should take a substantial form, thus giving a material guarantee of our appreciation of his efforts to benefit mankind. It has been said "that the man who makes two blades of grass grow where one only grew before is a benefactor to his species"; how much more is he who gives us an abundant supply of a perfectly new, nutritious, and palatable article of food. I have brought with me this evening a specimen of the starch granules of the *Macrozamia* mounted dry. The smaller grains are chiefly round, rarely oval, the larger are perfect ovoids, resembling so many small birds' eggs. They differ from the other varieties of starch, as depicted in the second part of the second volume of the third edition of Pereira's "Materia Medica," and are "*sui generis*." I have also brought a specimen frond of the plant for your inspection.

REFERENCES TO ENGRAVINGS:—

No. 1. *Macrozamia* spiralis.
No. 2. Female cone.
No. 3. Male cone.
No. 4. Under view of male cone bearing anthers (nat. size).
No. 5. Seed (nat. size).
No. 6. Granules of *Macrozamia* starch, magnified 390 diameters.

TRANSVERSE SECTION OF FANG OF HUMAN TOOTH, SHOWING CASE OF EXOSTOSIS.

By Mr. Hugh Paterson.

[*Read before the Microscopical Section of the Royal Society of N. S. W., 20 September, 1876.*]

The fangs of the teeth are, under ordinary circumstances, covered on the external surface with a thin layer of cementum, but when, whether from caries or any other cause, irritation of the dental periosteum takes place, it gives rise—in some constitutions—to the morbid growth termed exostosis, if the word may be allowed to pass muster, as strictly speaking it is the cementum, a modified form of bone, which is here enlarged.

"Mr. Jones, who has made careful microscopical examinations of this substance, describes it as being similar to osseous tissue, its structure being composed of minute granules closely united, the individual granules being about the $\frac{1}{10,000}$ of an inch in diameter. Scattered through the so-formed tissue are cells from which numerous tortuous tubes proceed, the tubes themselves freely anastomosing with each other and with those sent from neighbouring cells; by this arrangement a network of cells and tubes, permeable by fluids, is carried throughout the whole mass. When the cement exists in any quantity it is traversed by canals for blood-vessels."

The interest attached to this disease is mainly due to the derangement it may cause to the nervous system. In my younger days, when in London, I had occasion to remove some eighteen teeth and stumps, all more or less affected by exostosis, before permanent relief was afforded.

Another case which may be of interest to this Section, on account of the name of the sufferer, was that of the late Rev. Wm. Quekett, brother of the late Professor John Quekett, whose labours as a pioneer in microscopical research are well known and respected. The offending tooth in this case was an upper molar; it caused great and long continued suffering, and the exostosis was of a very extensive nature.

This tooth is in the Hunterian Museum of the Royal College of Surgeons of London. I remember that at the time it impressed me as bearing some distant resemblance to a rustic garden stool, so nodulated and distorted were the fangs by the hypertrophy of the cementum.

NOTES ON TWO SPECIES OF INSECTIVOROUS PLANTS INDIGENOUS TO THIS COLONY.

BY J. U. C. COLYER.

[*Read before the Microscopical Section of the Royal Society of N.S.W., 24 November,* 1876.]

ON August 28th, 1874, a most interesting address was delivered by Dr. Hooker at the British Association in Belfast, Ireland, on the subject of Insectivorous Plants, and more especially with reference to that known as *Dionœa muscipula* (Venus's Fly-trap). So great was the interest taken at the time on this subject of vegetable carnivora, that illustrations appeared in the *Graphic* of plants possessing this peculiar property, and grown in the Royal Botanic Gardens, Kew. Since then my attention has been directed towards certain plants indigenous to this country, belonging to the order of *Droseraceæ* or "Sun-dews" and more particularly to the *Drosera spathulata*, and *Drosera binata*, specimens of which I now beg to place before this meeting.

They are both found in marshy or swampy ground near Sydney, and are attractive to the eye by the numerous sparkling minute drops of clear fluid, like dew, adhering to the long slender filaments by which the edge and upper surface of the leaves are surrounded.

On warm days this peculiarity seems to be greater, or in no way decreased, as might naturally be supposed, by the extreme heat of a mid-day sun.

This fluid is of a glutinous nature, forming an attraction to flies and other insects, all of which find certain death, when once they alight on either the mid-rib of the frond of *Drosera binata*, or are entangled in the viscous globules exuded by either plants on the outer ends of their filaments.

The order to which these plants belong have not only been considered insectivorous in their habits, but also carnivorous, and as many of you may be aware, have been subjected to minute and careful examination with various experiments, by such eminent men as Professor Darwin, Dr. Klein, Dr. Hooker, Dr. Burdon Sanderson, and others, all of whom concur in the one opinion, viz.: that they are beyond doubt vegetable carnivora.

The *Drosera spathulata*, so called from the resemblance of its leaves to the spathula used by chemists, has a remarkable starry appearance, and is of a dun-red colour, each leaf fringed round with numerous filaments or tentacles. I have never noticed the plant to exceed two (2) inches in diameter.

The flowers are racemed, or borne in bunches on a stem rising from the centre to a height of about five (5) inches, and are pure white.

The *Drosera binata* is a much larger plant, and of an entirely different appearance, though, like the former, the sides and upper surface of the leaves are armed with tentacles of considerable length, some extending half an inch, and the points of each bearing small pear-shaped knobs or glands, from which issue the clear viscid fluid.

It attains a height sometimes in favourable localities of twenty (20) inches; each stalk is of a rush-like character, and bearing two blade-leaves of almost an eighth of an inch in width—bifurated once always, and sometimes more. These not unfrequently attain a length of seven and a half (7½) inches from its junction with the stalk; the mid-rib of each being hollowed out on both sides, but more on the inner, giving the appearance of grooves. The apex of the blades is extremely fine, terminating in very long tentacles.

The flowers are similar in many respects to *Drosera spathulata* with the exception that the stalk issues immediately from the root and is of a chocolate colour, differing in that particular from the stalks of the leaves, which are green.

Seen under a microscope with a low power, the leaf presents a curious and most interesting appearance; the whole of the mid-rib often completely covered with the remains of insects caught, and apparently dissolved or digested, and upon examination these are found to be but the mere shells or cases of the former flies, all of which are found longitudinally placed on the mid-rib of the blade, and their natural hue changed to black. Even bush ants half an inch in length I have seen unable to extricate themselves from the tentacles, the marginal rows possessing the marvellous power of closing over their victims and gluing them firmly to the smaller and shorter glands rising from the centre of the blade.

When insects are thus entrapped, their struggles to become free excite the glands to such an extent that they immediately inflect on the irritating object, and the glutinous matter (which, by the way, has been proved to be albumen), heretofore possessing little or no acridity, now appears by the inflected action of the tentacles to have changed its nature and become most acrid, litmus paper being immediately tinged with it. Mr. Darwin states, in his work on "Insectivorous Plants" (page 86), referring to an experiment on the leaves of *Drosera rotundifolia* (a plant resembling *Drosera spathulata*) that "The secrètion of many glands on thirty leaves, which had not in any way been excited, was tested with litmus paper; and the secretion of twenty-two of these leaves did not in the least affect the colour, whereas

that of eight caused an exceedingly feeble and sometimes doubtful tinge of red. Two other old leaves, however, which appeared to have been inflected several times, acted much more decidedly on the paper. Particles of clean glass were then placed on five of the leaves, cubes of albumen on six, and bits of raw meat on three, on none of which was the secretion at this time in the least acid. After an interval of twenty-four hours, when almost all the tentacles on these fourteen leaves had become more or less inflected, I again tested the secretion, selecting glands which had not as yet reached the centre or touched any object, and it was now plainly acid. The degree of acidity of the secretion varied somewhat on the glands of the same leaf."

The secretion so discharged has been examined by Dr. Darwin, in order to ascertain whether this acrid matter approaches to the gastric juice or digestive material found in the stomachs of animals, and the experiment showed that "the acid belongs to the acetic or fatty series" (see page of "Insectivorous Plants" 88.)

Professor Frankland observed of the fluid taken from the filaments of *Drosera rotundifolia* that "when acidified with sulphuric acid it emitted a powerful odour like that of pepsin."

By the kindness of Mr. Hirst, the Secretary of this Section of the Royal Society, I have been enabled to examine with his microscope the structure of these plants, more especially *Drosera binata.* On placing one of the tentacles of the latter under a low magnifying power its structure is fairly displayed. It consists of a straight, pale green hair, carrying at the end a balloon or pear-shaped gland, of a red or scarlet hue, in some cases more brilliant than others; but on increasing the power to 1,400 diameters, by a sixteenth inch immersion lens, the character of the gland is more clearly defined. We see that the spiral vesicle which traverses the centre of the pedicel increases in breadth as it approaches the gland, and divides into two branches, each branch of which, as it reaches the centre of the gland, doubling backwards and forwards on itself several times, the whole at first sight having the appearance of pistil of a poppy. The spiral vesicle passes from the gland down the pedicel to the mid-rib of the frond, and in *that* also, upon further investigation, can this spiral arrangement of cells be found.

The pedicel bearing the gland is apparently divided lengthwise into rows of elongated cells; those contiguous to the spiral formation being filled with a fluid containing granules of matter, frequently found in an aggregated condition, but having an ever-changeful irregular motion. This matter is frequently understood by the word "*protoplasm.*" In *Drosera rotundifolia,* Darwin states that in the course of a few minutes he has noticed these germs undergo many changes, and that they pass up and

down the walls of the cells through the fluid, uniting, separating, and reuniting, being never at rest, "presenting a wonderful scene of vital activity." Referring to *Drosera binata*, I would again remark that I have noticed this action is entirely confined to the cells next the spiral column or duct.

It has been surmised that the inflection of the tentacle is produced by the contraction of the cells, caused by the pressure of the irritating or exciting object, and consequent increased aggregation of the germs against the walls in the cells, sending its motor impulse down the tentacle to the base, at which part it seems to bend, but considerable difference of opinion has been expressed on this point. Mr. Darwin says:—"On the whole, the belief that the walls of certain cells contract, some of their contained fluid being at the same time forced outwards, perhaps accords best with the observed facts. If this view is rejected, the next most probable one is that the fluid contents of the cells shrink, owing to a change in their molecular state, with the consequent closing in of the walls. Anyhow, the movement can hardly be attributed to the elasticity of the walls, together with a previous state of tension."

No comparison can be made with the action of the "Sensitive Plant" (*Mimosa pudica*) in the closing of its leaflets when irritated, this being merely mechanical and assumed nightly by the plant as if in repose, whereas the secretion from the inflected tentacles continues without interruption until the whole of the juices of the exciting object have been absorbed. The effect of a shower of rain on the Sensitive Plant would immediately close the leaflets, whereas heavy rain or water falling in large drops from a considerable height do not in the least move the tentacles of the *Drosera*.

On observing some of the inflected tentacles after the capture of an insect, one cannot but be struck with the change effected in them, compared with those taken from the plant in its normal condition. The red colouring matter, heretofore confined to the gland, has now descended the green pedicel as far as the base, and apparently granulated into cakes, also on the outside of the gland towards the head may be seen numerous black nuclei, possibly the mouths of channels leading into the spiriferous cells of the same, nevertheless the protoplasm in the pedicel is still moving, though slowly, and slightly agglomerated. This would in a measure show a tendency of the fluid to flow towards the mid-rib of the frond caused by the action of absorption.

Placing small pieces of raw meat on a healthy full-grown plant, I found that within three hours the marginal tentacles were inflected, and in twenty-four hours the meat was completely enveloped in their folds—the leaves as well as the tentacles of *Drosera spathulata* being entirely curled over it. On separating

some of the tentacles from this plant they presented the same granulated appearance.

The effect of the application of heat by boiling is to produce coagulation of the albumen, and render the whole of the glands opaque, and of a brilliant white porcelain appearance,—the tentacles are immediately bowed back, and the whole of the frond rendered flaccid; but on submitting another portion of the frond to either the fumes of strong ammonia, or immersion in a very slight solution of liquid ammonia and water, the result obtained was the instant inversion of the marginal tentacles, the total disappearance of the red colour from the whole of the glands, and the matter in them agglomerated into black nuclei. But upon boiling a section of the frond in a solution of caustic potash and distilled water, to obtain a better view of the structure of the spiral cells, I discovered that the back of the mid-rib of the frond was studded with a number of stomata or breathing-vessels, which heretofore have apparently not been observed.

On repeating the same experiment on some of the inflected tentacles which had enveloped a common house-fly, the black spots which before were seen arranged around the head of the gland now vanished, proving in a negative manner that they consisted of nitrogenous matter absorbed into the orifices by the plant.

One other remarkable feature deserving especial notice are a number of dorsal tentacles, having no power of movement, yet capable of absorbing nutritive juices.

I have noted with some curiosity the occasional presence of a small insect or fly on the fronds of the *Drosera binata*, from about a quarter to half an inch in length, smooth and glossy, of a red colour, with black and white spots on the backs of the bodies, and long clean legs, devoid of hairs. It possesses the remarkable power of walking all over the fronds without in any way being impeded, or entrapped (as all other insects are) by the treacherous drops of viscid fluid exuded from and adhering to the glands. Most plants have their insect enemies, such as worms, &c., which draw their nutriment from the leaves which they devour; but strange to say, this particular fly does not seem to destroy the blades of the *D. binata* in the least, and only lives on the dead insects captured by the closing of the tentacles—also in one instance when fragments of raw meat were placed on the blades, the fly seemed to be attracted towards them.

There are many other points too numerous to mention in a paper of this length connected with these truly wonderful plants, and which would amply reward careful study. Several eminent authorities—Dr. Darwin especially—have given them much attention, and have written apparently exhaustively on the subject, but a careful observer will note much that has been left

unexplained, and many phenomena connected with their structure and habits, as yet untouched upon. There is a large field here that would amply repay a little perseverance, and even the few facts already observed and which I have endeavoured to put before you to-night, cannot but strike with wonder when viewed for the first time.

That the animal and vegetable kingdoms are in many respects closely allied none I think will be disposed to deny. Vegetable food is we know the means of subsistence to the bulk of animal life on the globe, but here we have an example actually of the reverse; for it has been proved that if these plants be deprived of the means of obtaining sustenance through the insects caught by them, as for example by enclosing them in a glass shade, they quickly become sickly and die, their roots not being formed for extracting nitrogenous or organic matter from the ground.

SECTION F.—GEOGRAPHY AND ETHNOLOGY.

At the preliminary meeting of this Section the following Committee was appointed:—

CHAIRMAN.—Mr. E. Du Faur, F.R.G.S.

COMMITTEE.—J. Manning, C. L. Sahl, A. S. Webster, The Hon. L. Fane De Salis, M.L.C.

HON. SECRETARY.—Wm. Forde.

Owing to the absence of some of the Committee from Sydney, it was not thought advisable to call the Section together until the September meeting, at which arrangements were made for the preparation of lists from the Public Libraries of this and the neighbouring Colonies, and from other sources, of all works bearing on Exploration in Australasia and the Islands of the Pacific, also for collating all information published on the Aborigines.

These matters are proceeding.

Tracings of Ice Charts showing the track of ships running down easting have been promised to this Section from the original belonging to Commodore Hoskins, R.N.

Commander Hoskins, R.N., of H.M.S. "Pearl," and Lieutenant Penn, of H.M.S. "Sappho," have kindly promised charts showing the recent alterations in surveys, and also discoveries made by the Admiralty in the Pacific.

The Free Librarian of Tasmania has forwarded a list of works on Exploration and the Aborigines. The Librarian Melbourne, and the Secretary of the South Australian Institute, have promised similar contributions.

The meetings of the Section have been so sparsely attended by members hitherto that no steps have been taken beyond making the preliminary arrangements above referred to.

E. DU FAUR,
Chairman.

WM. FORDE,
Hon. Secretary, Section F.

SECTION G.—LITERATURE AND FINE ARTS, INCLUDING ARCHITECTURE.

There have been six meetings of this Section, at three of which quorums have not been formed.

PRELIMINARY MEETING, TUESDAY, 27 JUNE, 1876.

Fourteen members joined, and the following elected office-bearers:—

CHAIRMAN.—E. L. Montefiore.
HON. SEC.—H. A. Lenehan.
COMMITTEE.—E. Du Faur, L. F. De Salis, G. Morell, W. G. Murray..

Business meetings arranged for fourth Monday of each month during session, and that the subject for first business meeting should be "Processes of Photographic Reproduction."

MONDAY, 24 JULY, 1876.

Mr. E. L. MONTEFIORE in the Chair.

Several members were present. A considerable number of examples of the various photographic reproductions were exhibited by members of the Section, also some of the pellicle patented by Mr. Kennett, of London, for his dry plate process. Mr. Russell submitted, for the information of the members, the cost of obtaining the use of Woodbury's patent, obtained by him from that gentleman during his recent visit to Europe. The plates exhibited printed by the process obtained from Mr. Woodbury himself were exceedingly beautiful. This process was considered to give not only much greater detail in the pictures, but greater rapidity in reproduction than other processes. After a lengthened discussion as to the various processes, it was resolved,—"That a letter be prepared, and submitted for the approval and signatures of the members, at the next general meeting of the Society, asking the Government to procure, for the use of the Government Printing Office, the process invented and patented by Mr. Woodbury, by which photographs taken direct from natural objects could be printed with all the truth-

fulness and detail of an ordinary silver print." In illustrating works of the natural history of the Colony, its buildings, public works, &c., it was considered that the process would be very valuable, and might very soon be made reproductive. It was resolved,—"That Count de Zaba be invited to attend the next meeting of the Section, to be held on the 28th proximo, for the purpose of explaining to the members his method for facilitating the study of universal history and literature."

The letter to the Government was signed by twenty-one members at general meeting.

MONDAY, 28 AUGUST, 1876.

Count De Zaba was present by invitation, and in a conversational way gave a description of his method of historical teaching.

MONDAY, 25 SEPTEMBER, 1876.

No quorum.

MONDAY, 23 OCTOBER, 1876.

No quorum.

MONDAY, 27 NOVEMBER, 1876.

The last meeting of the session. Mr. E. L. Montefiore read a very interesting paper on Etching and Etchers, illustrated by etchings by Rembrandt and others.

ETCHING AND ETCHERS.

By E. L. Montefiore.

[*Read before the Literature and Fine Art Section of the Royal Society of N.S.W.*, 27 *November*, 1876.]

He commenced by alluding to the common error of styling pen and ink drawings etchings, explaining that an etching was a drawing produced on a metal plate, by means of lines or strokes bitten in or corroded by the action of acid, from which impressions were afterwards taken through the medium of a printing-press—the artist's ideas being thus capable of reproduction; and that whilst it required a certain amount of skill in the use of pen or pencil to produce a good etching, a person might produce any charming pen and ink drawings although utterly ignorant of the art of etching. Mr. Montefiore then proceeded to show the difference between etching and engraving, the latter being more of a mechanical process, the effect being produced by a series of regular lines and dots, executed on metal with the "burin" without the aid of acid, and necessarily not possessing the freedom of the etching, in the execution of which the artist allows his needle to wander freely over the plate, as though he were drawing with pen or pencil, leaving it to the acid to give the necessary gradations of light and shade. Quoting from Gilbert Hammerton, himself an experienced etcher, he remarked that the central idea of etching was the free expression of purely artistic thought, and that of all the arts known it was the best fitted for that especial purpose. The ideal of an etching, said that writer, is that it should be free and spontaneous. When a plate has been laboriously corrected it always showed signs of fatigue, and so lost in freshness what it might have gained in delicacy and force. A certain kind of self-reliance, almost approaching a conviction of his own personal value, was necessary to an aquafortist. The needful elements of success in direct work of any kind was absolute sincerity and simplicity. Good etching, like good manners, did not hesitate about what is to be said or done, and though highly sensitive, was not painfully self-conscious. Above all, it casts away affectation, the vice of the inferior arts. Etching does not condescend, and therefore really need not be at the trouble to polish its phrases and explain. The truth of these remarks he considered abundantly exemplified in the works of Rembrandt, the great representative master of the art of etching.

Mr. Montefiore then proceeded to describe the various processes used by the etcher—viz., pure etching, dry point, aqua-tint, and soft ground etching. That these processes might be more clearly understood by the members present, he exhibited the various tools used in the differeut processes, and explained their uses, showing the plates in different states of progress. He also gave a lengthened and interesting account of the method of preparing the copper plates used in etching. As showing the necessity of reversing the drawing where accuracy was required, he instanced a curious error in an etching of the Life School of the Royal Academy, by Cope, the Royal Academician, in which the whole of the students are seen drawing with their left hands, whilst the model is drawing a sword from his right side.

Mr. Montefiore proceeded to observe that etching was believed to have been invented about forty years later than engraving, and was commonly practised in Germany in 1512; but that the great master of etching, whose name would always be associated with the art, was Rembrandt, who flourished in the early part of the 17th century. He then expatiated at some length on Rembrandt's marvellous skill as an etcher, the great apparent negligence of his etchings, their remarkable boldness and freedom, and wonderful distribution of light and shade. He stated that essays had been written on them in France, Holland, Germany, and England, and that Adam Bartsch, himself an engraver, keeper of the print room in the Vienna Museum, writing of him in 1797, said—"However great may be the reputation Rembrandt has acquired by his paintings, he is no less celebrated by his etchings, which have at all times excited the admiration of connoisseurs; a vagabond liberty, a picturesque disorder, an easy touch, the rarest perception of chiaroscuro, and the talent of expressing the character of the different ages and subjects he was treating, by touches thrown in as it were by chance. Such are some of the elements, and there are many others, which constitute the merit of Rembrandt as an engraver, which give such an inexpressible charm to his prints." Rembrandt, it was said, would never etch in any person's presence, so that many of his processes are unknown. As showing Rembrandt's wonderful rapidity, Mr. Montefiore related the following anecdote:—That being at table with his great friend and patron Burgomaster Six, the mustard-pot was asked for, and not being on the table, the servant was sent to fetch it. Rembrandt, knowing the tardiness of the domestic, laid a wager with his friend that he would commence and finish an etching before he returned, a feat he actually accomplished, the plate being known as "Six's Bridge, or the Mustard Pot." Remarking on the large sums given for Rembrandt's etchings, Mr. Montefiore stated that an impression of his portrait of the Burgomaster alluded to, which was generally

considered one of the most finished and perfect of Rembrandt's etchings, was sold in London in June last for £270, one of his celebrated portraits of Von Tolling for £500, and one of Ephraim Bonus, the Jewish physician, for £160. At this sale about 200 of his etchings realized £4,293. "Christ healing the Sick," better known as the 100-guilder piece, from the fact that Rembrandt would never sell an impression under 100 guilders (about eight guineas), was considered as Rembrandt's masterpiece. At a sale in London, in 1867, of Sir C. Price's collection, a copy of this in the first state of the plate realized the enormous sum of £1,180. The British Museum was supposed to contain one of the finest collections of Rembrandt's etchings. Mr. Montefiore then alluded to other celebrated painters of the 17th century who were skilful etchers, enumerating amongst others, Claud, Annibal Carraci, Rubens, Van Dyck, Ostade, Teniers, Salvator Rosa, Berghem, Paul Potter, &c.; he also dwelt on the works of Callot and Della Bella, two very prolific etchers who flourished during the same period.

Mr. Montefiore remarked that the art of etching had not been much practised or appreciated in England, although England had produced some very good etchers. Some years back a few artists had formed themselves into an Etching Club, and had published some of their etchings from time to time, which had been much sought after. Amongst English etchers might be mentioned—Turner, who, however, merely employed the needle for outline, filling in with mezzotint; Landseer in his early days had published a series of etchings; Wikie, David Roberts, Cope, Ansdell, Hunt, Millais, Creswick, Redgrave, &c., also etched. At the present day he considered that there was no English etcher equal to Seymour Haden, of wicker coffin celebrity, an amateur, and surgeon by profession. There was a boldness and free handling about his work not approached by any other etcher of the English school, and indeed there were few contemporary etchers equal to him elsewhere. Mr. Montefiore submitted for the inspection of the members a very fine example of Haden's, called the "Breaking-up of the Old Agamemnon" to which, at the time of its publication, the *Times* devoted a column and a half. He stated that there had been a great revival of the art of etching in France of late years, owing in great measure to the exertions of the well-known and enterprising publisher, Monsieur Cadart, who had made the printing and publication of etchings a speciality—his prints were, as a rule, much superior to those produced in England. Having already alluded to some of the old masters of the French school of etchers, such as Claude, Callot, &c., he would not occupy their time further by dwelling at length on the modern school, but would in conclusion, merely allude to one who might with justice be considered at its head,

viz., Maxime Lalanne, of whom it had been said that whilst there were etchers of greater power and more striking originality, there was never one equal to him in a certain delicate elegance from the earliest times till now. Maxime Lalanne was the first artist who ever received knighthood for his skill as an etcher, that honor having been conferred on him by the King of Portugal, himself an etcher. Mr. Montefiore illustrated his paper by a very interesting collection of etchings by ancient and modern artists, including works by Rembrandt, Berghem, Paul Potter, Hollar, Callot, Della Bella, Landseer, Lalanne, Haden, Millais, Jaquemart, Appian, Otto Weber, &c.

An interesting discussion then followed on the merits of the various processes: and before the meeting dispersed, a very cordial vote of thanks was accorded to Mr. Montefiore for his very interesting paper, with the request that he would allow it to be published.

The Chairman stated that, at a future meeting, he hoped, through the kindness of Messrs. J. Fairfax and Sons, that the members of the section would have an opportunity afforded them of seeing specimens of the process of electrotyping which was now largely used in printing.

SECTION H.—MEDICAL SCIENCE.

Dec. 2, 1876.

To the Honorary Secretaries of the Royal Society of New South Wales.

GENTLEMEN,

In pursuance of By-law No. XXX, we have the honor to forward a report of the proceedings of the Medical Section during the past session. The first meeting of the Section took place on June 28th. Alfred Roberts, Esq., was elected Chairman, and Drs. Cox, Cosby, Morgan, and Milford, and G. A. Wright, Esq., were elected Members of Committee. Dr. P. Sydney Jones was elected Honorary Secretary. At a subsequent meeting Dr. MacLaurin was associated with Dr. Jones in the Secretaryship. The monthly meetings have been fairly attended; pathological and other specimens have been exhibited, and interesting papers have been read. Rules for the guidance of the members of the Section have been drawn up, printed, and adopted. Donations have been made by Drs. Cox, Schuette, Ward, and Sydney Jones.

ALFRED ROBERTS, Chairman.

P. SYDNEY JONES, } Honorary
H. W. MACLAURIN, M.D., } Secretaries.

SECTION I.—SANITARY SCIENCE.

Report of the Social and Sanitary Science Section of the Royal Society for the session of 1876.

To the President of the Royal Society.

Sir,

I have the honor to submit the following report:—

The Social Science and Statistics Section held a preliminary meeting on the 29th June, when it was unanimously resolved that a proposition be submitted to the Council that Section H. Sanitary Science be joined to Section I, Social Science and Statistics. The proposal having been agreed to, the Section has since that date met as the Social and Sanitary Section.

At its first meeting, held on the 10th July, Mr. Roberts, M.R.C.S., was chosen as Chairman; Dr. Morgan, and Messrs. Bedford, M.R.C.S., Voss, and Tarleton were elected a Committee; and Mr. Harrie Wood was appointed Honorary Secretary.

The Section then decided that its ordinary meetings be held on the second Tuesday in each month.

Steps were taken to procure all the papers, etc., published by the Sydney and Suburban Sewage and Health Board, by the Victorian Central Board of Health, and by the English Board of Health, but the publications of the last-named Board have not yet been received.

At the meeting held on the 8th August, Dr. BELGRAVE called attention to the Vital Statistics published by the Registrar General, and pointed out certain defects therein. After careful consideration, it was generally admitted that in many cases the cause of death as stated rendered the statistics of comparatively small value as a basis for sanitary legislation. The defects appeared to be mainly due to want of care or want of skill on the part of the persons by whom certificates of death are granted; and in order to ascertain the facts a series of questions were submitted to the Honorable the Colonial Secretary. These questions elicited the following replies:—1. That the primary cause of death is given in all cases where specified in the certificate. 2. That the certificate of death is required principally for the purpose of statistics upon which sanitary legislation may be based. 3. That the Nosological table used here is the same as that used by the Registrar General of England. 4. That the statistics include deaths certified by persons other than legally qualified medical practitioners, but in what proportion is not at present known. These replies having been discussed, it was resolved that the papers be referred to the Medical Section, with a request that the members will consider the matter and favour this Section with the result of their deliberations.

On the 12th September Dr. BELGRAVE read a paper on "Preventable Disease and Sanitary Organization." The consideration of this paper engaged the attention of the Section at an ordinary and three special meetings. The subject was divided under three heads, and dealt with as follows:—1. That the poisons of cholera and typhoid fever are communicable by filtered water, and that there is danger of the Botany water supply becoming contaminated by organic poison. 2. That an efficient system of registration of infectious and contagious diseases, with a view to arresting their further development, would be beneficial to the community. 3. That the decomposition of filth can give rise to specific fevers. 4. That venereal disease is prejudicial to public health, and is more or less reducible under the combined influence of education and legislation. 5. That a State sanitary organization is urgently required in New South Wales. It was then resolved that the Royal Society be invited by this Section to wait upon the Government by deputation, and urge it to introduce during the next Session an efficient General Public Health Act and to appoint a Central Board with ample powers to see its provisions enforced.

On the 26th September Dr. BELGRAVE drew attention to the statistics of the mortality in the principal cities of Continental Europe recently published in the Journal of the British Medical Association, from which Sydney, in spite of its almost unrivalled natural hygienic advantages, is shown to be at present one of the most unhealthy cities in Christendom.

On the 10th October Mr. ROBERTS, M.R.C.S., laid on the table a memorandum which he had prepared at the request of the Colonial Secretary upon hygiene, especially in its bearings upon epidemics. Mr. Roberts also read some remarks on the measures adopted by him under the Government to prevent the spread of erysipelas. A communication was received from M. Jules Joubert forwarding a photograph of an apparatus for cleaning water-pipes, and asking the Section to move the Royal Society to offer a prize for the best display of exhibits in the Sanitary Department of the Agricultural Society's next Exhibition. The Section at a subsequent meeting adopted the following resolution:—That, in the opinion of the Social and Sanitary Science Section, the Royal Society might with advantage to the community co-operate *with* the Committee of the Agricultural Society in promoting the exhibition of all articles tending to advance sanitary science and improve sanitary appliances.

Dr. BELGRAVE called attention to the prevalence of small-pox in San Francisco, and the danger of the disease being brought to this Colony by means of the mail steamers from that port. It was generally admitted that the danger is great, and that precautionary measures should as far as practicable be taken,

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ALFRED ROBERTS,
Chairman.

APPENDIX.

ABSTRACT OF THE METEOROLOGICAL OBSERVATIONS TAKEN AT THE SYDNEY OBSERVATORY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 40s; MAGNETIC VARIATION 9° 32′ 45″ East.

JANUARY, 1876.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	30·093 inches on the 27th, at 4 a.m.	
	Lowest Reading	29·278 „ on the 5th, at 2 p.m.	
	Mean Height	29·713	

(Being 0·058 inch less than that in the same month on an average of the preceding 17 years.)

Wind ...	Greatest pressure... ...	11·0 lbs. on the 20th	
	Mean Pressure	0·8 lb.	
	Number of Days Calm ...	0	
	Prevailing Direction ...	E.N.E.	

(Prevailing direction during the same month for the preceding 17 years, N.E.)

Temperature	Highest in the Shade ...	90·8	On the 19th.
	Lowest in the Shade ...	57·7	On the 6th.
	Greatest Range	20·2	On the 8th.
	Highest in the Sun ...	131·6	On the 19th.
	Highest in Black Box with Glass Top	195·2	On the 19th.
	Lowest on the Grass ...	50·0	On the 6th.
	Mean Diurnal Range ...	12·7	
	Mean in the Shade ...	72·6	

(Being 1·5 greater than that of the same month on an average of the preceding 17 years.)

Humidity ...	Greatest Amount... ...	97·0	On the 20th.
	Least	50·0	On the 19th.
	Mean	74·0	

(Being 1·2 greater than that of the same month on an average of the preceding 17 years.)

Rain... ...	Number of Days	16 rain and 2 dew.	
	Greatest Fall	0·468 inch.	On the 5th.
	Total Fall...	0·967 „	65 ft. above ground.
		1·421 „	15 in. above ground.

(Being 2·027 inches less than than of the same month on an average of the preceding 17 years.)

Evaporation	Total Amount	9·392 inches.	
Ozone ...	Mean Amount	5·7	

(Being 1·2 greater than that in the same month on an average of the preceding 16 years.)

Electricity...	Number of Days Lightning	6	
Cloudy Sky...	Mean Amount	6·4	
	Number of Clear Days ...	0	
Meteors ...	Number Observed ...	4	

Remarks.

The mean barometer is slightly below, and the mean temperature 1·5 above the average of this month for the past 17 years. Rain has been frequent but very light at Sydney; and generally over the Colony the dry weather has continued, doing great damage to pastoral and agricultural interests. At a few of the stations, on the high lands and on the coast, there has been sufficient rain. Thunderstorms have been frequent, and hail fell on 2nd, 5th, 16th, and 20th. Hot winds are recorded on the 1st and 2nd at Narrabri, on the 8th at Moss Vale, and on the 12th at Wentworth.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 32′ 45″ East.

FEBRUARY, 1876.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	30·052 inches on the 28th, at 9 p.m.
	Lowest Reading	29·209 „ on the 10th, at 12 noon.
	Mean Height	29·782

(Being 0·012 inch less than that in the same month on an average of the preceding 17 years.)

Wind ...	Greatest Pressure... ...	12·5 lbs. on the 26th.
	Mean Pressure	1·0 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	S.

(Prevailing direction during the same month for the preceding 17 years S.)

Temperature	Highest in the Shade ...	96·9	On the 25th.
	Lowest in the Shade ...	57·5	On the 24th.
	Greatest Range	34·0	On the 25th.
	Highest in the Sun ...	132·0	On the 25th.
	Highest in Black Box with Glass Top ...	186·8	On the 26th.
	Lowest on the Grass ...	45·7	On the 24th.
	Mean Diurnal Range ...	12·9	
	Mean in the Shade ...	71·0	

(Being 0·4 greater than that of the same month on an average of the preceding 17 years.)

Humidity ...	Greatest Amount... ...	99·0	On the 10th.
	Least	45·0	On the 25th.
	Mean	71·1	

(Being 4·0 less than that of the same month on an average of the preceding 17 years.)

Rain... ...	Number of Days	14 rain and 1 dew.	
	Greatest Fall	0·523 inch.	On the 28th.
	Total Fall...	0·902 inch.	65 ft. above ground.
		1·360 inch.	15 in. above ground.

(Being 5·468 inches less than that of the same month on an average of the preceding 17 years.)

Evaporation	Total Amount	7·696 inches.
Ozone ...	Mean Amount	7·1

(Being 2·5 greater than that in the same month on an average of the preceding 16 years.)

Electricity...	Number of Days Lightning	7
Cloudy Sky...	Mean Amount	6·6
	Number of Clear Days ...	1
Meteors ...	Number Observed ...	2

Remarks.

This month has been exceedingly dry and hot; from nearly all parts of the Colony come accounts of severe drought, and heavy losses in consequence; in one case a whole flock of 10,000 sheep died while going to water, and the number of dead sheep and cattle in the back country is immense. In Sydney the rainfall for the month is 5½ inches less than the average, and it is less than that for any February since 1854. The temperature has been above and the humidity 4·0 below the average, so that evaporation has been very great, and in many places water, even for household purposes, has been obtained with difficulty. In the suburbs not supplied by water pipes the price of water has been from 5s. to 10s. per cask. On the 16th a very severe cyclone occurred at Bowen, in Queensland; it destroyed everything in its direct track, and carried some wooden houses bodily a considerable distance; the storm was accompanied by thunder and balls of fire, one of which made a round hole into one of the houses. On the 23rd a water spout was seen at sea off Cape St. George. On the 26th and 27th tides in Sydney harbour were unsteady, and at 2·30 p.m. of the 27th the water in harbour suddenly rose 5 inches in twelve minutes. From 5 p.m. on 26th to morning of 27th the barometer was very unsteady at Sydney, and from 2 to 2·35 p.m. of 27th it rose rapidly, and at the end of that time fell 0·050 in 5 minutes, the fall being almost coincident with the rise in the water. At New Zealand a heavy earthquake shock occurred at 3 a.m., and another at 9 a.m., on the 26th; smaller shocks were felt for some days.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 32′ 45″ East.

MARCH, 1876.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	30·068 inches on the 22nd, at 10 p.m.
	Lowest Reading	29·448 „ on the 25th, at 3·45 a.m.
	Mean Height	29·848

(Being 0·047 inch less than that in the same month on an average of the preceding 17 years.)

Wind ...	Greatest Pressure.... ...	13·5 lbs. on the 31st.
	Mean Pressure	0·7 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	E.

(Prevailing direction during the same month for the preceding 17 years N.E.)

Temperature	Highest in the Shade ...	89·6	On the 26th.
	Lowest in the Shade ...	54·6	On the 31st.
	Greatest Range	24·3	On the 24th.
	Highest in the Sun ...	127·0	On the 25th.
	Highest in Black Box with Glass Top ...	187·7	On the 16th.
	Lowest on the Grass ...	43·6	On the 31st.
	Mean Diurnal Range ...	12·5	
	Mean in the Shade ...	71·9	

(Being 2·9 greater than that of the same month on an average of the preceding 17 years.)

Humidity ...	Greatest Amount... ...	94·0	On the 13th.
	Least	30·0	On the 30th.
	Mean	71·1	

(Being 5·5 less than that of the same month on an average of the preceding 17 years.)

Rain... ...	Number of Days	9 rain and 2 dew.	
	Greatest Fall	0·294 inch.	On the 17th.
	Total Fall...	0·166 inch.	65 ft. above ground.
		1·419 inch.	15 in. above ground.

(Being 5·316 inches less than that of the same month on an average of the preceding 17 years.)

Evaporation	Total Amount	7·336 inches.
Ozone ...	Mean Amount	6·9

(Being 2·0 greater than that in the same month on an average of the preceding 16 years.)

Electricity...	Number of Days Lightning	5
Cloudy Sky...	Mean Amount	5·8
	Number of Clear Days ...	1
Meteors ...	Number Observed ...	4

Remarks.

The drought of the past months still continues generally, a few stations only have had useful rain, and the effects of the continued dry weather are most serious; cattle and sheep are said to be dying in immense numbers, and fears are entertained that no grass can grow before the frosts, even if rain comes at once. At Sydney the total rainfall for the month was only 0·419 inch, or less than that for any March during the last 36 years, or the whole period on record. Evaporation has also been very great, and the temperature 2·9 above the average.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 32′ 45″ East.

APRIL, 1876.—GENERAL ABSTRACT.

Barometer... At 32° Faht.	Highest Reading	30·244 inches on the 10th, at 9 p.m.
	Lowest Reading	29·461 „ on the 5th, at 1·45 p.m.
	Mean Height	29·832

(Being 0·167 inch less than that in the same month on an average of the preceding 17 years.)

Wind ...	Greatest Pressure... ...	9·7 lbs. on the 9th.
	Mean Pressure	0·5 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	W.N.W.

(Prevailing direction during the same month for the preceding 17 years W.)

Temperature	Highest in the Shade ...	87·0	... On th 5th.
	Lowest in the Shade ...	52·6	... On the 18th.
	Greatest Range	27·0	... On the 4th.
	Highest in the Sun ...	121·7	... On the 5th.
	Highest in Black Box with Glass Top	172·5	... On the 4th.
	Lowest on the Grass ...	39·5	... On the 30th.
	Mean Diurnal Range ...	15·5	
	Mean in the Shade ...	65·8	

(Being 0·8 greater than that of the same month on an average of the preceding 17 years.)

Humidity ...	Greatest Amount... ...	100·0	... On the 13th.
	Least	32·0	... On the 5th.
	Mean	72·7	

(Being 5·4 less than that of the same month on an average of the preceding 17 years.)

Rain... ...	Number of Days	10 rain and 2 dew.	
	Greatest Fall	1·685 inch.	On the 14th.
	Total Fall	4·637 inch.	65 ft. above ground.
		5·246 inch.	15 in. above ground.

(Being 2·108 inches less than that of the same month on an average of the preceding 16 years.)

Evaporation	Total Amount	4·850 inches.
Ozone ...	Mean Amount	6·9

Being 1·0 greater than that in the same month on an average of the preceding 17 years.)

Electricity...	Number of Days Lightning	8
Cloudy Sky...	Mean Amount	4·5
	Number of Clear Days ...	4
Meteors ...	Number Observed ...	6

Remarks.

The temperature of the first few days of the month was very high, and reached the extreme degree for this month 87·0° on the 5th. The dry weather continued to the 7th, when welcome rain began at northern stations and gradually extended southwards. It was however principally confined to the coast districts, and very little fell west of the dividing range. The greatest fall was 19·690 inches at Port Macquarie, of this 9·750 fell on the 15th. Places reached by the rain had in most cases sufficient to relieve the drought, but to the west the drought still continues, and the losses from want of water and grass are very great; at Wilcannia and Upper Darling, teams cannot travel for want of water.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10^h 4^m 46^s; MAGNETIC VARIATION 9° 32′ 45″ East.

MAY, 1876.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading...	... 30·345 inches on the 15th, at 8·55 a.m.	
	Lowest Reading...	... 29·537 ,, on the 30th, at 11 a.m.	
	Mean Height ...	... 29·999	

(Being 0·072 inch greater than that in the same month on an average of the preceding 17 years.)

Wind ...	Greatest Pressure	... 12·5 lbs. on the 7th.	
	Mean Pressure ...	... 0·5 lb.	
	Number of Days Calm ...	2	
	Prevailing Direction ...	W.	

(Prevailing direction during the same month for the preceding 17 years W.)

Temperature	Highest in the Shade ...	76·6	On the 12th.
	Lowest in the Shade ...	49·8	On the 14th.
	Greatest Range	17·3	On the 3rd.
	Highest in the Sun ...	111·3	On the 22nd.
	Highest in Black Box with Glass Top ...	155·6	On the 13th.
	Lowest on the Grass ...	40·1	On the 10th.
	Mean Diurnal Range ...	10·4	
	Mean in the Shade ...	60·1	

(Being 1·7 greater than that of the same month on an average of the preceding 17 years.)

Humidity ...	Greatest Amount ...	100·0	On the 7th and 20th.
	Least	51·0	On the 13th.
	Mean	82·4	

(Being 6·6 greater than that of the same month on an average of the preceding 17 years.)

Rain... ...	Number of Days... ...	21 rain and 2 dew.	
	Greatest Fall	2·815 inches.	On the 22nd.
	Total Fall	10·435 inches.	65 ft. above ground.
		13·166 inches.	15 in. above ground.

(Being 8·525 inches greater than that of the same month on an average of the preceding 17 years.)

Evaporation	Total Amount	1·795 inches.	
Ozone ...	Mean Amount	7·5	

(Being 2·8 greater than that in the same month on an average of the preceding 16 years.)

Electricity...	Number of Days Lightning	2	
Cloudy Sky...	Mean Amount	6·5	
	Number of Clear Days ...	1	
Meteors ...	Number Observed ...	5	

Remarks.

The weather this month has been unusually mild, with abundant rains generally over the Colony, excepting the southern and south-western parts, where the drought unfortunately still prevails. On the coast the rains have been specially heavy, reaching a maximum of 19 inches about Port Macquarie. 17 inches fell at Cape George, and 13 inches at Sydney. At other stations, with the exception mentioned, the amount has varied from 3 inches to 12 inches. The mean temperature at Sydney was 1·7° greater than the average, and the warm weather at the early part of the month, combined with the April rains, brought many of the fruits into blossom (on the 15th), which it is feared will prevent them blossoming in spring.

GOVERNMENT OBSERVATORY, SYDNEY.

Latitude 33° 51′ 41″; Longitude $10^h\ 4^m\ 46^s$; Magnetic Variation 9° 32′ 45″ East.

JUNE, 1876.—General Abstract.

Barometer ... At 32° Faht.	Highest Reading	30·418 inches on the 19th, at 10·30 a.m.	
	Lowest Reading	29·446 „ on the 16th, at 12 noon.	
	Mean Height	29·957	
(Being 0·030 inch greater than that in the same month on an average of the preceding 17 years.)			
Wind ...	Greatest Pressure... ...	15·7 lbs. on the 17th.	
	Mean Pressure	0·7 lb.	
	Number of Days Calm ...	0	
	Prevailing Direction ...	W.N.W.	
(Prevailing direction during the same month for the preceding 17 years W.)			
Temperature	Highest in the Shade ...	68·8	On the 15th.
	Lowest in the Shade ...	41·1	On the 19th.
	Greatest Range	21·3	On the 19th.
	Highest in the Sun ...	102·7	On the 15th.
	Highest in Black Box with Glass Top	132·6	On the 15th.
	Lowest on the Grass ...	35·5	On the 19th.
	Mean Diurnal Range ...	13·7	
	Mean in the Shade ...	54·1	
(Being 0·7 less than that of the same month on an average of the preceding 17 years.)			
Humidity ...	Greatest Amount... ...	100·0	On the 20th, 25th, 27th, and 29th
	Least	43·0	On the 15th.
	Mean	76·7	
(Being 0·4 less than that of the same month on an average of the preceding 17 years.)			
Rain... ...	Number of Days	7 rain and 6 dew.	
	Greatest Fall	2·028 inches.	On the 27th.
	Total Fall	3·495 inches.	65 ft. above ground.
		4·419 inches.	15 in. above ground.
(Being 1·456 inches less than that of the same month on an average of the preceding 17 years.)			
Evaporation	Total Amount	2·196 inches.	
Ozone ...	Mean Amount	7·5	
(Being 2·2 greater than that in the same month on an average of the preceding 17 years.)			
Electricity...	Number of Days Lightning	4	
Cloudy Sky...	Mean Amount	3·5	
	Number of Clear Days ...	8	
Meteors ...	Number Observed ...	2	

Remarks.

The weather during the month has been clear and cold, with barometer rather above the average, and prevailing westerly winds. Rain fell at Sydney on seven days; but the amount is 1·456 inch below the average of this month. The excessive quantity of ozone, 2·2 above the average is remarkable, considering the prevalence of westerly winds. Generally along the coast a moderate quantity of rain has fallen, ranging from 2 to 9 inches; but inland the month has been very dry, and in many places the drought still continues. The minimum barometer at Sydney occurred on the 16th, followed by a cold W.N.W. gale and lightning at night. On the 17th snow fell at Orange, Goulburn, and Cooma. On the 22nd a very high tide visited Sydney.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 40s; MAGNETIC VARIATION 9° 32′ 45″ East.

JULY, 1876.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	30·313 inches on the 31st, at 8 a.m.
	Lowest Reading	29·481 „ on the 27th, at 2 a.m.
	Mean Height	29·945

(Being 0·007 inch greater than that in the same month on an average of the preceding 17 years.)

Wind ...	Greatest Pressure ...	17·4 lbs. on the 21st.
	Mean Pressure	1·5 lb.
	Numbers of Days Calm ...	0
	Prevailing Direction ...	W.N.W.

(Prevailing direction during the same month for the preceding 17 years W.N.W.)

Temperature	Highest in the Shade ...	61·9	On the 11th.
	Lowest in the Shade ...	39·1	On the 31st.
	Greatest Range	22·6	On the 31st.
	Highest in the Sun ...	99·9	On the 9th.
	Highest in Black Box with Glass Top	131·6	On the 24th.
	Lowest on the Grass ...	33·3	On the 31st.
	Mean Diurnal Range ...	11·3	
	Mean in the Shade ...	52·8	

(Being 0·5 greater than that of the same month on an average of the preceding 17 years.)

Humidity ...	Greatest Amount... ...	100·0	On the 13th, 17th, and 22nd.
	Least	52·0	On the 29th.
	Mean	80·4.	

(Being 6·6 greater than that of the same month on an average of the preceding 17 years.)

Rain	Number of Days	18 rain and 5 dew.
	Greatest Fall	1·675 inches, on the 14th.
	Total Fall	4·370 inches. 65 ft. above ground.
		6·741 inches. 15 in. above ground.

(Being 2·602 inches greater than that of the same month on an average of the preceding 17 years.)

Evaporation	Total Amount	2·331 inches.
Ozone ...	Mean Amount	7·8

(Being 2·7 greater than that in the same month on an average of the preceding 15 years.)

Electricity...	Number of Days Lightning	5
Cloudy Sky...	Mean Amount	5·9
	Number of Clear Days ...	3
Meteors ...	Number Observed ...	7

Remarks.

The month has been wet and windy at Sydney, and generally along the coast districts. In the western districts the rainfall, if any, has been small, and at some places the drought still continues. On the 13th and 14th a strong easterly gale, with deluges of rain, came on, and extended from Queensland right down the coast to Eden; in some parts of Queensland the floods were higher than ever before known. There were high floods in the Clarence (here the greatest on record, the city was almost all under water) and Macleay Rivers on 15th, and moderate floods in the Hunter on 16th. There was a terrific fall of rain in New England, and at Tenterfield upwards of nine inches fell in one day. There was a partial return of this weather on 21st and 22nd. At 4 a.m of 19th a very severe shock of earthquake in New Zealand.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 32′ 45″ East.

AUGUST, 1876.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading ...	... 30·333 inches on the 1st, at 11 a.m.	
	Lowest Reading ...	... 29·419 „ on the 24th, at 9 p.m.	
	Mean Height ...	... 29·956	

(Being 0·013 inch greater than that in the same month on an average of the preceding 17 years.)

Wind ...	Greatest Pressure	... 12·5 lbs. on the 7th and 17th.	
	Mean Pressure ...	... 0·7 lb.	
	Number of Days Calm ...	0	
	Prevailing Direction ...	W.N.W.	

(Prevailing direction during the same month for the preceding 17 years W.)

Temperature	Highest in the Shade ...	72·1	On the 31st.
	Lowest in the Shade ...	40·8	On the 19th.
	Greatest Range ...	23·5	On the 31st.
	Highest in the Sun ...	109·0	On the 30th and 31st.
	Highest in Black Box with Glass Top ...	162·5	On the 31st.
	Lowest on the Grass ...	34·8	On the 19th.
	Mean Diurnal Range ...	14·6	
	Mean in the Shade ...	54·8	

(Being 0·3 greater than that of the same month on an average of the preceding 17 years.)

Humidity ...	Greatest Amount... ...	100·0	On the 4th, 15th, and 23rd.
	Least	48·0	On the 31st.
	Mean	76·5	

(Being 6·5 greater than that of the same month on an average of the preceding 17 years.)

Rain... ...	Number of Days	14 rain and 5 dew.	
	Greatest Fall	0·552 inch, on the 23rd.	
	Total Fall...	0·936 inch. 65 ft. above ground.	
		1·295 inch. 15 in. above ground.	

(Being 1·546 inch greater than that of the same month on an average of the preceding 17 years.)

Evaporation	Total Amount	3·096 inches.	
Ozone ...	Mean Amount	7·7	

(Being 2·8 greater than that in the same month on an average of the preceding 15 years.)

Electricity...	Number of Days Lightning	8	
Cloudy Sky...	Mean Amount	4·5	
	Number of Clear Days ...	3	
Meteors ...	Number Observed ...	3	

Remarks.

The weather has been dry and hot, with prevalent westerly winds during the month. At Sydney the rainfall is less than half the average for the month, and at all stations except Orange the rainfall has been small. Lightning has been frequent at Sydney, and the Zodiacal light has been very bright, on the 12th extending to an altitude of 45°

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 32′ 45″ East.

SEPTEMBER, 1876.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	30·174 inches on the 23rd.	
	Lowest Reading	29·082 „ on the 14th.	
	Mean Height	29·828	

(Being 0·061 less than that in the same month on an average of the preceding 17 years.)

Wind ...	Greatest Pressure... ...	117·0 lbs. on the 10th.	
	Mean Pressure	1·3 lb.	
	Number of Days Calm ...	0	
	Prevailing Direction ...	W.N.W.	

(Prevailing direction during the same month for the preceding 17 years W.)

Temperature	Highest in the Shade ...	81·3	On the 21st.
	Lowest in the Shade ...	43·4	On the 13th.
	Greatest Range	28·9	On the 19th.
	Highest in the Sun ...	117·8	On the 19th.
	Highest in Black Box with Glass Top	188·5	On the 19th.
	Lowest on the Grass ...	40·1	On the 17th.
	Mean Diurnal Range ...	14·6	
	Mean in the Shade ...	59·2	

(Being 0·7 greater than that of the same month on an average of the preceding 17 years.)

Humidity ...	Greatest Amount... ...	98·0	On the 29th.
	Least	35·0	On the 1st.
	Mean	70·3	

(Being 1·5 greater than that of the same month on an average of the preceding 17 years.)

Rain... ...	Number of Days	11 rain and 3 dew.	
	Greatest Fall	1·967 inches.	On the 11th.
	Total Fall	1·993 inches.	65 ft. above ground.
		3·505 inches.	15 in. above ground.

(Being 1·279 inches greater than that of the same month on an average of the preceding 17 years.)

Evaporation	Total Amount	4·903 inches.
Ozone ...	Mean Amount	7·6

(Being 2·4 greater than that in the same month on an average of the preceding 16 years.)

Electricity...	Number of Days Lightning	4
Cloudy Sky...	Mean Amount	5·0
	Number of Clear Days ...	2
Meteors ...	Number Observed ...	1

Remarks.

The dry weather continued until the 10th instant, when a very severe storm of wind and rain came from the southward along the coast, and inland from the south as far as the Lachlan River. The interior to north of this is still suffering severely from drought.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 32′ 45″ East.

OCTOBER, 1876.—GENERAL ABSTRACT.

Barometer... At 32° Faht.	Highest Reading	30·004 inches on the 3rd.	
	Lowest Reading	29·386 „ on the 20th.	
	Mean Height	29·721	
(Being ·120 greater than that in the same month on an average of the preceding 17 years.)			
Wind ...	Greatest Pressure ...	12·5 lbs. on the 6th.	
	Mean Pressure	0·7 lb.	
	Number of Days Calm ...	0	
	Prevailing Direction ...	W.N.W.	
(Prevailing direction during the same month for the preceding 17 years, N.E.)			
Temperature	Highest in the Shade ...	82·1	On the 23rd.
	Lowest in the Shade ...	48·2	On the 3rd.
	Greatest Range	24·2	On the 17th.
	Highest in the Sun ...	121·9	On the 23rd.
	Highest in Black Box with Glass Top	203·4	On the 23rd.
	Lowest on the Grass ...	40·1	On the 1st.
	Mean Diurnal Range ...	14·6	
	Mean in the Shade ...	63·1	
(Being 0·5 less than that of the same month on an average of the preceding 17 years.)			
Humidity ...	Greatest Amount... ...	97·0	On the 4th.
	Least	37·0	On the 12th.
	Mean	73·7	
(Being 5·5 greater than that of the same month on an average of the preceding 17 years.)			
Rain... ...	Number of Days... ...	14	
	Greatest Fall	0·840 inch.	On the 8th.
	Total Fall...	1·956 „	65 ft. above ground.
		2·841 inches.	15 in. above ground.
(Being 0·316 greater than that of the same month on an average of the preceding 17 years.)			
Evaporation	Total Amount	5·155 inches.	
Ozone ...	Mean Amount	6·0	
(Being 0·7 than that in the same month on an average of the preceding 16 years.)			
Electricity...	Number of Days Lightning	13	
Cloudy Sky..	Mean Amount	5·0	
	Number of Clear Days ...	0	
Meteors ...	Number Observed ...	3	

Remarks.

Nice rains fell along the coast about the middle of the month. Inland the weather has been dry, and a remarkable phenomenon has occurred with regard to cattle and horses; those with white patches, or all white, have been attacked by a kind of aphis and all the white hair removed, aphis has also been very prevalent on vegetables.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 32′ 45″ East

NOVEMBER, 1876.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	30·122 inches on the 30th, at 10 a.m.
	Lowest Reading	29·254 „ on the 19th, at 4 a.m.
	Mean Height	29·630

(Being 0·191 inch less than that in the same month on an average of the preceding 17 years.

Wind ...	Greatest Pressure... ...	15·1 lbs. on the 5th and 25th.
	Mean Pressure	1·1 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	S.S.W.

(Prevailing direction during the same month for the preceding 17 years N.E.)

Temperature	Highest in the Shade ...	92·8	... On the 12th.
	Lowest in the Shade ...	50·8	... On the 25th.
	Greatest Range	28·6	... On the 7th.
	Highest in the Sun ...	127·4	... On the 12th.
	Highest in Black Box with Glass Top	203·2	... On the 12th.
	Lowest on the Grass ...	44·5	... On the 25th.
	Mean Diurnal Range ...	13·7	
	Mean in the Shade ...	67·3	

(Being 0·9 greater than that of the same month on an average of the preceding 17 years.)

Humidity ...	Greatest Amount... ...	100·0	On the 17th and 18th.
	Least	38·0	On the 10th.
	Mean	73·0	

(Being 3·9 greater than that of the same month on an average of the preceding 17 years.)

Rain... ...	Number of Days	13
	Greatest Fall	2·108 inches on the 17th.
	Total Fall	3·468 inches. 65 ft. above ground. 4·824 inches. 15 in. above ground.

(Being 1·328 inches greater than that of the same month on an average of the preceding 17 years.)

Evaporation	Total Amount	6·804 inches.
Ozone ...	Mean Amount	6·1

(Being 1·1 greater than that in the same month on an average of the preceding 16 years.)

Electricity...	Number of Days Lightning	11
Cloudy Sky..	Mean Amount	7·0
	Number of Clear Days ...	2
Meteors ...	Number Observed ...	3

Remarks.

The mean temperature this month is 0·9 above the average, and along the coast valuable rains have fallen, but inland the drought is still pressing in many places. Trees did blossom this spring. (See note in May.)

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE $10^h\ 4^m\ 46^s$; MAGNETIC VARIATION 9° 32′ 45″ EAST.

DECEMBER, 1876.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	30·106 inches	on the 18th, at 10 a.m.
	Lowest Reading	29·251 „	on the 26th, at 2 a.m.
	Mean Height	29·785	

(Being 0·035 inch greater than that in the same month on an average of the preceding 17 years.)

Wind ...	Greatest Pressure ...	14·6 lbs.	on the 16th.
	Mean Pressure	0·9 lb.	
	Number of Days Calm ...	0	
	Prevailing Direction ...	E.N.E.	

(Prevailing direction during the same month for the preceding 17 years, N.E.)

Temperature	Highest in the Shade ...	88·3	On the 15th.
	Lowest in the Shade ...	53·4	On the 4th.
	Greatest Range	24·5	On the 14th.
	Highest in the Sun ...	126·9	On the 16th.
	Highest in Black Box with Glass Top	206·5	On the 18th.
	Lowest on the Grass ...	49·1	On the 2nd.
	Mean Diurnal Range ...	14·3	
	Mean in the Shade ...	70·0	

(Being 0·6 greater than that of the same month on an average of the preceding 17 years.)

Humidity ...	Greatest Amount... ...	94·0	On the 12th.
	Least	36·0	On the 27th.
	Mean	68·8	

(Being 1·1 greater than that of the same month on an average of the preceding 17 years.)

Rain... ...	Number of Days	9	
	Greatest Fall	0·290 inch.	On the 27th.
	Total Fall...	0·228 inch.	65 ft. above ground.
		0·453 inch.	15 in. above ground.

(Being 1·857 inches less than that of the same month on an average of the preceding 17 years.)

Evaporation	Total Amount	8·566 inches.
Ozone ...	Mean Amount	6·1

(Being 1·6 greater than that in the same month on an average of the preceding 16 years.)

Electricity...	Number of Days Lightning	6
Cloudy Sky...	Mean Amount	5·6
	Number of Clear Days ...	4
Meteors ...	Number Observed ...	4

Remarks.

The temperature this month has been high, and the barometer rather above the average. Rain has been light generally, except in New England where it has been abundant. To south and west inland the continued dry weather is severely felt.

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Sydney: Charles Potter, Acting Government Printer.—1877.

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